THE HISTOLOGY OF THE URINARY SYSTEM OF THE MINK, *MUSTELA VISION*

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THE HISTOLOGY OF THE URINARY SYSTEM OF THE MINK, *MUSTELA VISION*

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INTRODUCTION

From an economic standpoint, losses suffered due to urinary tract pathology such as urolithiasis (Nielson, 1956), urinary incontinence (Schaible *et al.*, 1962; Aulerich *et al.*, 1963), "Wet Belly" (Leoschke, 1962; Aulerich *et al.*, 1963), and Aleutian disease (Karstad and Pridham, 1962; Leader *et al.*, 1963; Gershbein and Spencer, 1964; Thompson and Aliferis, 1964) are of extreme importance to the mink rancher. A thorough review of the literature indicated that there were no reports available on the normal histology of the urinary system of the mink. Because a previous knowledge of the normal is essential in recognizing the abnormal, a histological study of the urinary tract of the normal mink (*Mustela vision*) was undertaken.

MATERIALS AND METHODS

The entire urinary systems of eight male and eight female clinically normal mink were supplied by the Michigan State University mink ranch (Table 1). The animals, ranging in age from one month to two years, were fed a normal ranch diet (Table 2).

Twelve of the animals were killed by cervical dislocation. Their urinary tracts were dissected out and immediately placed in a 10% formalin solution buffered with sodium acetate or in Carnoy's fixative (Gridley, 1957). The tissues were kept in the fixative for 48 hours prior to embedding.

Because of the extreme difficulty in preserving the cytological detail of the kidney, the urinary systems of the remaining four animals were fixed with a perfusion of buffered formalin. This was accomplished by first anesthetizing the animals with an intraperitoneal injection of 3% sodium pentabarbital (1 ml./kg. of body weight). After the animals were anesthetized, the carotid artery and the external jugular vein were cannulated and the vascular system flushed via the carotid artery with mammalian Ringer's solution. This was followed immediately with an infusion of buffered formalin. After infusion, the urinary tract was dissected out and placed in a solution of buffered formalin for 48 hours.

Table 1.--Specimens used in the study.

Specimen Number	Mink Number	Age in Months	Weight in Grams	Sex	Color Pattern
1	K 381	10	1,550	Male	Dark
2	KP 181	12	1,460	Male	Pastel
3	K 371	12	1,850	Male	Dark
4	KP 2	14	950	Female	Pastel
5	KP 52	2	480	Female	Pastel
6	K 264	14	815	Female	Dark
7	K 470	1	155	Female	Dark
8	L 70	2.5	705	Female	Dark
9	KP 183	14	1,600	Male	Pastel
10	JS 322	24	770	Female	Sapphire
11	K 310	13	965	Female	Dark
12	KP 707	12	1,800	Male	Pastel
13	LP 272	7	785	Female	Pastel
14	L 167	7	1,300	Male	Dark
15	K 315	12	1,635	Male	Dark
16	L 631	6	965	Male	Dark

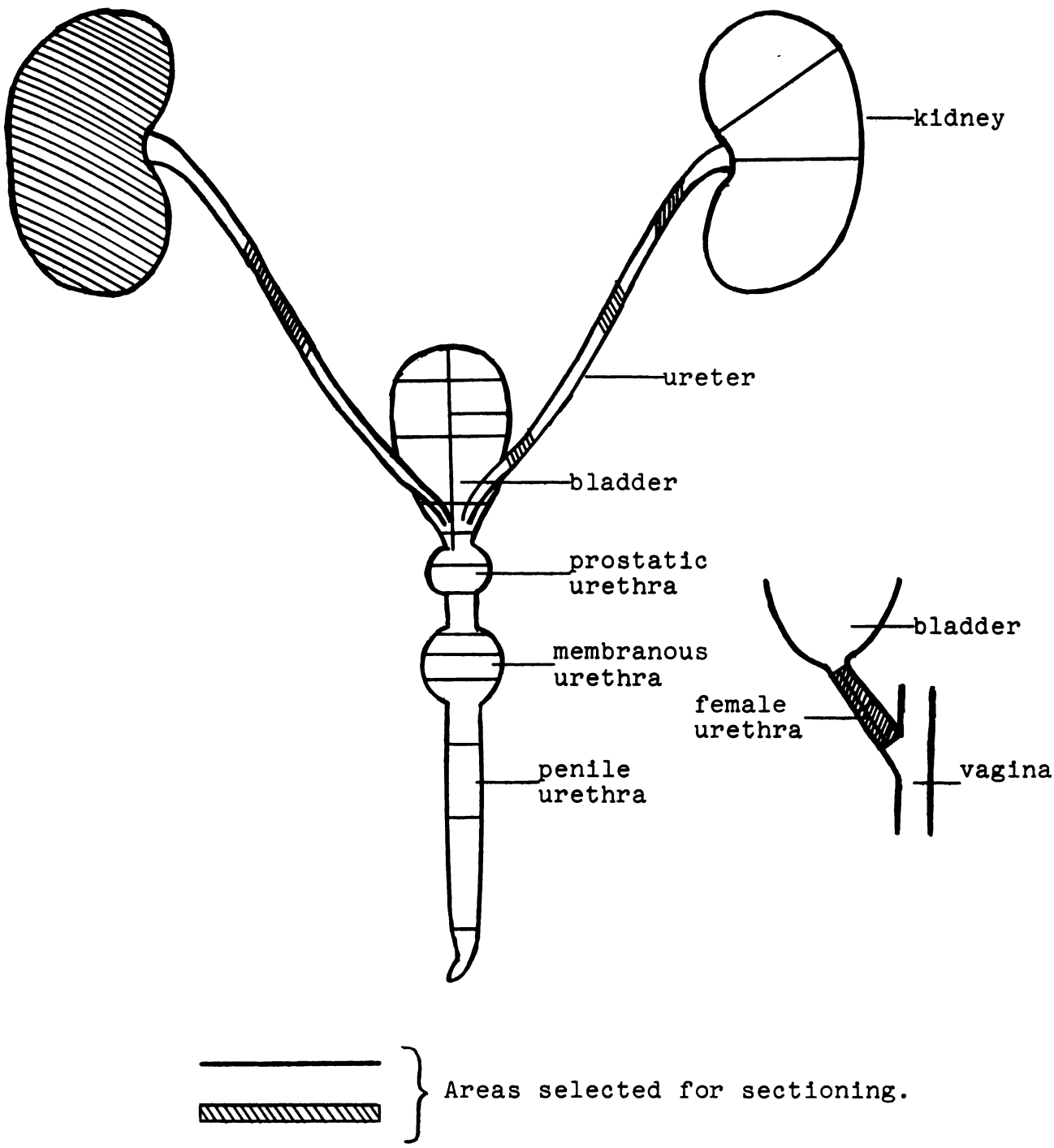
Table 2.--Analysis of the ration fed to the animals used in this study.

Moisture	67.99%
Protein	10.81%
Ether extract	13.35%
Crude fiber	5.69%
Ca	.22%
Ph	.23%
Na	.17%
K	.14%
Trace minerals	1.40%

Just prior to embedding, the tissues were removed from the fixatives and trimmed to block size. Areas from which tissues were selected for study are shown in Illustration 1. The tissues were dehydrated and cleared in four changes of dioxane (Bucher and Blakely, 1936) and infiltrated with Paraplast under a vacuum of 25 mm./Hg. at 58-60°C. for a period of one to two hours.

Unless otherwise indicated, sections were cut 6-8 microns. Hematoxylin and eosin (Malewitz and Smith modification, 1955), Weigert and Van Gieson's connective tissue stain (Mallory, 1944) and Periodic Acid-Schiff (Gridley, 1957) were used routinely. The following special techniques were also used: (1) A modified reticular tissue stain (Gridley, 1957; Lillie, 1954); (2) Alcian blue and nuclear fast red (Gridley, 1957) for acid mucopolysaccharides; (3) Crossmon's (1937) modification of Mallory's triple stain for connective tissue; and (4) Oil Red O (Mallory, 1944) and Sudan Black B (Chieffele and Putt, 1951) for lipid material. The last two stains were used on frozen sections as most lipids are dissolved by the paraffin embedding technique.

Illustration 1.--Areas of the urinary system from which tissues were selected for study.



RESULTS AND DISCUSSION

KIDNEY

The mink kidney is bean-shaped and unipyramidal with the papillary ducts opening on a renal crest rather than a renal papilla. This is similar to the cat and dog kidney (Trautmann and Fiebiger, 1957).

CAPSULE

The capsule of the mink kidney is composed of an inner and an outer coat. The outer coat is much thicker and consists almost entirely of adipose tissue with a few blood vessels and nerves coursing through it (Figure 1). The inner coat is primarily fibrous connective tissue interlaced with reticular fibers, some of which penetrate the cortex of the kidney (Figure 1). No smooth muscle or elastic connective tissue is noted. This is similar to the inner one-layered tunica fibrosa of the cat kidney (Yadava and Calhoun, 1958).

URINIFEROUS TUBLES

Nephron

Renal Corpuscle.--The renal corpuscles as well as the glomeruli are spherical and have an average transverse diameter of 115 and 95.5 microns, respectively. The parietal

and visceral layers of Bowman's capsule, as in other animals, are lined with a layer of simple squamous epithelium. The intercapillary space contains a few reticular fibers and an occasional fibroblast.

Proximal Convoluted Tubule.--The average transverse diameter and epithelial height of the proximal convoluted tubules are 39.9 and 11.3 microns, respectively. They are lined by a single layer of pyramidal and/or low columnar shaped cells with granular acidophilic cytoplasm (Figure 3). Numerous intracytoplasmic lipid droplets, which are Sudan Black B and Oil Red O positive, are present in the epithelium lining the proximal tubules and those of the thick descending limb of Henle as well (Figures 6 and 7). Similar lipid material has been reported in the cat kidney (Modell, 1933; Lobban, 1955; Stranack, 1962), in the dog kidney (Mac Nider, 1945) and in the kidney of the lion, tiger, cheetah and ocelot (Hewer et al., 1948). In most other animals and man this is considered pathologic. The basal portions of the cells lining the proximal convoluted tubules have a striated appearance due to the presence of numerous mitochondria in the form of rods and filaments which line up perpendicular to the basement membrane. The apical surface of the epithelium has a prominent brush border which increases the surface area of the cells. Its mucopolysaccharide makeup is evidenced by its P.A.S. positive reaction (Figures 4 and 5). The nuclei are large and usually spherical, contain a prominent nucleolus and have a coarse chromatic network. Cell boundaries are indistinct.

Loop of Henle.--The loop of Henle consists of a descending and an ascending portion connected by a sharp bend. It is divided into a thick and a thin segment. The epithelium lining the thick descending portion resembles that of the proximal convoluted tubule, and the epithelium of the thick ascending portion resembles that of the distal convoluted tubule. The thin segment has a diameter of 17.4 microns which is smaller than either the proximal or the distal tubules. It is lined by simple squamous or low cuboidal epithelium. Spherical bulging nuclei give an irregular contour to the lumen ot these tubules (Figure 7). The nuclei have a distinct nuclear membrane, a nucleolus and a dense granular chromatin network. The cytoplasm is slightly eosinophilic. A brush border is not visible with the light microscope.

Distal Convoluted Tubule.--The distal convoluted tubules have an average transverse diameter and epithelial height of 35.6 and 8.0 microns, respectively. They are lined by simple cuboidal epithelium. The cells have fine basal striations with faint borders. They are lower and smaller than those in the proximal tubules, so in a typical cross section more nuclei are seen. Their agranular cytoplasm is slightly more eosinophilic than that of the thin loop of Henle. The nuclei are characterized by a prominent nucleolus, a dense chromatin network, and a distinct nuclear membrane. Lipid material is not evident in the distal convoluted tubules (Figure 7).

Collecting Tubules

Arched and Straight Collecting Ducts.--The arched and straight collecting ducts are difficult to separate histologically and will be discussed together. They have an average transverse diameter and epithelial height of 33.1 and 7.0 microns, respectively. Light, eosinophilic staining, low cuboidal cells with distinct cell boundaries characterize the epithelium lining these ducts. They contain spherical, basally placed nuclei with an indistinct nucleolus and dense chromatin networks that stain darkly with hematoxylin. Basal striations are not apparent, and a brush border is lacking. The cells of the straight collecting tubules contain a few P.A.S. positive, Alcian blue negative, intracytoplasmic granules.

Papillary Ducts.--The papillary ducts have an average transverse diameter and epithelial height of 53.8 and 9.9 microns, respectively. The epithelial lining changes from cuboidal or low columnar at the origin of the ducts to high columnar and sometimes transitional as the ducts open into the renal pelvis. The cells have distinct boundaries but lack basal striations and brush borders. The cytoplasm is colorless or slightly eosinophilic. P.A.S. positive, Alcian blue negative intracytoplasmic granules are present in many of the cells lining these ducts (Figures 9 and 10). They are often most prominent in the apical portion of the cells and may occasionally be seen in the lumen of the tubules. In some cases these granules are found in the cells

of the epithelium covering the renal crest (Figure 8). These granules are similar to those mentioned by Longley et al., (1963) in the collecting tubules of normal guinea pigs and those in the pelvic epithelium covering the pyramids in the normal human kidney by Tucker et al., (1959). Karstad (1964) reported similar granules in 23 out of 40 mink showing lesions pathognomonic for Aleutian disease. These granules were also found in 8 out of 14 normal mink from the same study.

MACULA DENSA

The macula densa is a modification of that portion of the distal convoluted tubule that comes in contact with the juxtaglomerular apparatus of the afferent arteriole (Figures 3 and 4). This portion is lined by closely packed columnar shaped cells that lack distinct cell boundaries and basal striations. Visible granulation is lacking in the faintly acidophilic cytoplasm. The closely packed spherical or oval nuclei are larger in this area and seem to have a greater affinity for hematoxylin.

JUXTAGLOMERULAR APPARATUS

The juxtaglomerular apparatus is located near the vascular pole of the glomerulus where the afferent arteriole comes in contact with the macula densa of the distal convoluted tubule. It consists of enlarged, slightly basophilic, myoepithelioid cells in the tunica media of the afferent

arteriole (Figure 3). A summary of the kidney measurements is shown in Table 3.

Table 3.--Summary of kidney measurements.

	Microns
1. Renal corpuscle	115.0
2. Glomerulus	95.5
3. Proximal convoluted tubule	
a. Cross sectional diameter	39.9
b. Epithelial height	11.3
4. Thin loop of Henle	
a. Cross sectional diameter	17.4
b. Epithelial height	4.6
5. Distal convoluted tubule	
a. Cross sectional diameter	35.6
b. Epithelial height	8.0
6. Arched and straight collecting ducts	
a. Cross sectional diameter	33.1
b. Epithelial height	7.0
7. Papillary duct	
a. Cross sectional diameter	53.8
b. Epithelial height	9.9

URETER

The wall of the ureter is generally divided into tunica mucosa, tunica submucosa, tunica muscularis, and tunica adventitia. In the following discussion, the mucosa and submucosa will be described together as there is no sharp demarcation between the two.

TUNICA MUCOSA

Epithelium

The epithelium is transitional and varies from 1 to 8 cell layers in thickness (Figures 16 and 17). It has a cross sectional diameter varying from 9 to 98 microns. This wide variation in cell layers and cross sectional diameters is primarily due to the different degrees of lumenal distention at the time of fixation. Elongated spindle-shaped cells with hyperchromatic nuclei and slightly more eosinophilic cytoplasm than the remainder of the epithelium could occasionally be seen on the luminal border of the epithelium (Figures 15 and 16). P.A.S. positive material similar to that reported by Liu (1962) is present in the epithelial cytoplasm.

Lamina Propria

The lamina propria consists of loosely arranged collagenous connective tissue, blood vessels, lymphatics, nerves, diffuse lymphatic tissue, a few elastic fibers, and a supporting network of reticular fibers (Figure 12). The loose arrangement allows the epithelium to be thrown into longitudinal folds, and this folding is responsible for the characteristic stellate appearance of the lumen (Figure 15). There is an average of 6 major and minor folds in the proximal segment of the ureter, 6 in the middle segment and 5 in the distal segment of the ureter. A capillary plexus is present just beneath the epithelium (Figure 16). This is

similar to the capillary plexus present in the ureters of ruminants (Calhoun, 1959).

TUNICA MUSCULARIS

The tunica muscularis of the ureter consists of an inner longitudinal, middle circular, and an outer longitudinal layer of smooth muscle. The inner longitudinal layer thins out and the outer longitudinal layer thickens near the bladder (Figures 13, 14, and 15). The middle circular layer maintains a relatively constant thickness the entire length of the ureter (Figures, 13, 14, and 15). The dog, cat, pig, cow, sheep, goat and horse have a similar muscular arrangement (Calhoun, 1959).

TUNICA ADVENTITIA

A loosely arranged collagenous connective tissue rich in blood vessels, lymphatics, nerves and containing a few autonomic ganglia is characteristic of the adventitia throughout the length of the ureter (Figure 14). This is surrounded by a thick tunic of fat which is supplied by a sparse vascular and nerve supply (Figure 11).

URINARY BLADDER

TUNICA MUCOSA

Epithelium

The transitional epithelium lining the urinary bladder varies from three to four cell layers in thickness and from 29 to 46 microns in cross sectional diameter.

As in the ureter, this wide variation is primarily due to the different degrees of luminal distention at the time of fixation. The surface epithelial cells often have a slightly, greater affinity for eosin than the rest of the epithelium, and this tends to give a cuticle-like appearance to the luminal border. The large, umbrella, cuboidal and pear-shaped cells have oval or spherical vesicular nuclei. They contain one or more nucleoli and have little affinity for hematoxylin (Figures 21 and 22). Occasional elongated spindle-shaped cells with hyperchromatic nuclei are also seen. The basal and intermediary layers consist of cuboidal and columnal cells with spherical or oval nuclei that have a thin nuclear membrane and a faint diffuse chromatin network. The cell boundaries are indistinct and the cytoplasm is slightly eosinophilic. In a number of the areas, the surface cells are elongated and resemble the cornified cells in the stratum corneum of stratified squamous epithelium. In these areas and others, there seem to be a great many cells undergoing degenerative changes. Many of these cells have sloughed into the bladder lumen (Figure 22). This might possibly be a factor in the high incidence of urinary calculi in mink as these sloughed cells could easily act as foci for the deposition of the various mineral salts making up the calculi.

Lamina Propria

The lamina propria consists of a framework of reticular (Figure 18) and dense fibroelastic connective tissue interspersed with scattered lymphocytes, occasional solitary lymphoid nodules, numerous lymphatic and blood vessels and a few nerves. The blood vessels form a rich vascular bed just under the epithelium and occasionally appear to penetrate its basal layer (Figures 20 and 21).

Muscularis Mucosae

Small scattered bundles of smooth muscle arranged in circular, longitudinal and oblique planes comprise the muscularis mucosae. It serves to separate the mucosa from the submucosa and probably helps account for the marked folding of the mucosa in the contracted bladder (Figure 19).

TUNICA SUBMUCOSA

Except for being somewhat thinner, loosely arranged and slightly less vascular, the submucosa is similar to the lamina propria.

TUNICA MUSCULARIS

The tunica muscularis consists of two thick layers of smooth muscle usually arranged in an inner circular and outer longitudinal manner (Figure 19). On occasion these layers seem to either spiral or cross and give the appearance of an inner circular, outer longitudinal layer in one place and an inner longitudinal, outer circular layer in

another area on the same section. The muscle layers are supplied by numerous blood vessels, lymphatics and nerves. A few intramural autonomic ganglia are present between the various muscle bundles (Figure 23).

TUNICA ADVENTITIA

Loosely and densely arranged collagenous connective tissue, a few elastic fibers, numerous blood vessels, lymphatics, nerves and a few autonomic ganglia constitute the tunica adventitia. In some areas it is covered by a reflection of the peritoneum and, therefore, could be called a serosa (Figure 23).

FEMALE URETHRA

TUNICA MUCOSA

Epithelium

The lining of the female urethra varies from predominantly transitional epithelium at its origin, mixtures of transitional, stratified and pseudostratified columnar, and stratified squamous in the mid-portions (Figure 40) to primarily stratified squamous at the external urethral orifice (Figure 43). A few intraepithelial nests of mucous cells are present in all segments and are especially numerous in the proximal and middle portions (Figure 40). Invaginations of the epithelium (lacunae of Morgagni) containing saccular outpocketings of mucous secreting cells penetrate the lamina propria and occasionally extend deeply into the

submucosa (Figure 42). The mucous cells in both the intraepithelial nests and lacunae of Morgagni contain P.A.S. positive, Alcian blue negative, secretion granules located primarily in the apical portion of the cytoplasm. In some cases P.A.S. positive eosinophilic concretions resembling intraepithelial cysts could be seen distending the lumens of the tubules and glandular nests (Figure 42).

Lamina Propria

Fibroelastic and reticular connective tissue penetrated by invaginations of the epithelium from the luminal surface and ducts from the serous intramural and extramural glands in the tunica muscularis surround the numerous venous sinuses of the lamina propria-submucosa (Figures 38, 39, and 41). The venous sinuses are most prominent in the proximal and midportions and diminish somewhat near the urethral orifice.

MALE URETHRA

TUNICA MUCOSA

Epithelium

The epithelium lining the origin of the prostatic urethra is two to four cell layers in thickness, primarily transitional in nature with some areas resembling pseudostratified columnar and stratified cuboidal epithelium. The large spherical to oval nuclei have a medium to heavy chromatin network, a prominent nucleolus, and a heavy

nuclear membrane. Cell boundaries are faint or indistinct. In most cases the basal cells are similar to those on the apical surface. However, a few of the surface cells are noted undergoing degenerative changes, suggesting that they are about to be sloughed.

The prostatic portion of the proximal urethra is surrounded by the prostate gland which consists of multilobular mucous acini which empty via their ducts into the urethral lumen (Figures 24 and 25). The prostatic utriculus and the colliculus seminalis are evident in the middle of this area (Figure 28).

The epithelium lining the membranous and penile urethra is similar to that in the proximal urethra except there is a greater proportion of pseudostratified columnar and stratified columnar epithelium and a decrease in the amount of typical transitional epithelium (Figures 31 and 35). Near the urethral orifice the epithelium is lower and resembles stratified cuboidal epithelium (Figure 37).

Lamina Propria

The lamina propria of the male urethra consists of numerous venous sinuses surrounded by collagenous and reticular connective tissue. The venous sinuses of the prostatic and membranous urethra are less extensive than those in the penile urethra (Figures 26, 29, 34 and 36). In addition, the lamina propria of the male urethra contains numerous elastic fibers throughout its length (Figures 27, 32 and 33).

SUMMARY

Histologic studies were made on the entire urinary systems of eight male and eight female mink ranging in age from one month to two years.

The mink kidney is unipyramidal. The capsule has a single layered tunica fibrosa. The renal corpuscles and glomeruli are spherical and have an average transverse diameter of 115 and 95.5 microns, respectively. The epithelium of the proximal convoluted tubules and thick descending limbs of Henle have an average transverse diameter and epithelial height of 39.9 and 11.3 microns respectively and contain numerous intracytoplasmic lipid droplets. A brush border is uniformly arranged along the luminal border of these cells. The macula densa and juxtaglomerular apparatus are similar to those of other species.

The epithelium of the straight collecting ducts and papillary ducts contain varying numbers of P.A.S. positive, Alcian blue negative, intracytoplasmic granules which are often located in the apical portion of the cells.

The ureter is lined by transitional epithelium. A capillary plexus is located in the lamina propria adjacent to the base of the epithelium. The tunica muscularis consists of an inner logitudinal, middle circular and outer

longitudinal layer of smooth muscle. The inner layer thins out and the outer layer thickens near the bladder. The tunica adventitia is surrounded by a thick tunic of fat.

The urinary bladder is lined by transitional epithelium of varying thickness. A number of the surface cells have undergone degenerative changes and have sloughed into the bladder lumen. Numerous blood vessels form a rich vascular plexus just below the epithelium. Ossasionally some of these vessels could be seen penetrating the basal layers of the epithelium. Small, scattered, variously arranged bundles of smooth muscle comprise the muscularis mucosae. The tunica muscularis consists of two thick spiraling layers of smooth muscle.

The epithelium lining the female urethra varies from transitional to stratified squamous. Intraepithelial nests of mucous cells, lacunae of Morgagni and intraepithelial cysts are present in variable numbers. The lamina propria-submucosa consists of numerous venous sinuses surrounded by fibroelastic and reticular connective tissue. The venous sinuses are most prominent in the proximal and midportions of the urethra.

The epithelial lining of the male urethra is variable throughout its length. It is predominantly transitional at its origin, variably transitional, stratified and pseudostratified columnar throughout the remainder, except near the urethral orifice where it resembles stratified cuboidal.

Other than the size differences between the very young and the adult animals and the differences between the male and female urethra, no obvious sex or age differences are noted.

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Figure 1.--Kidney Capsule

1. Outer adipose connective tissue portion of the kidney capsule.

2. Inner fibrous connective tissue portion of the kidney capsule.

3. Kidney cortex.

Hematoxylin and eosin x 32

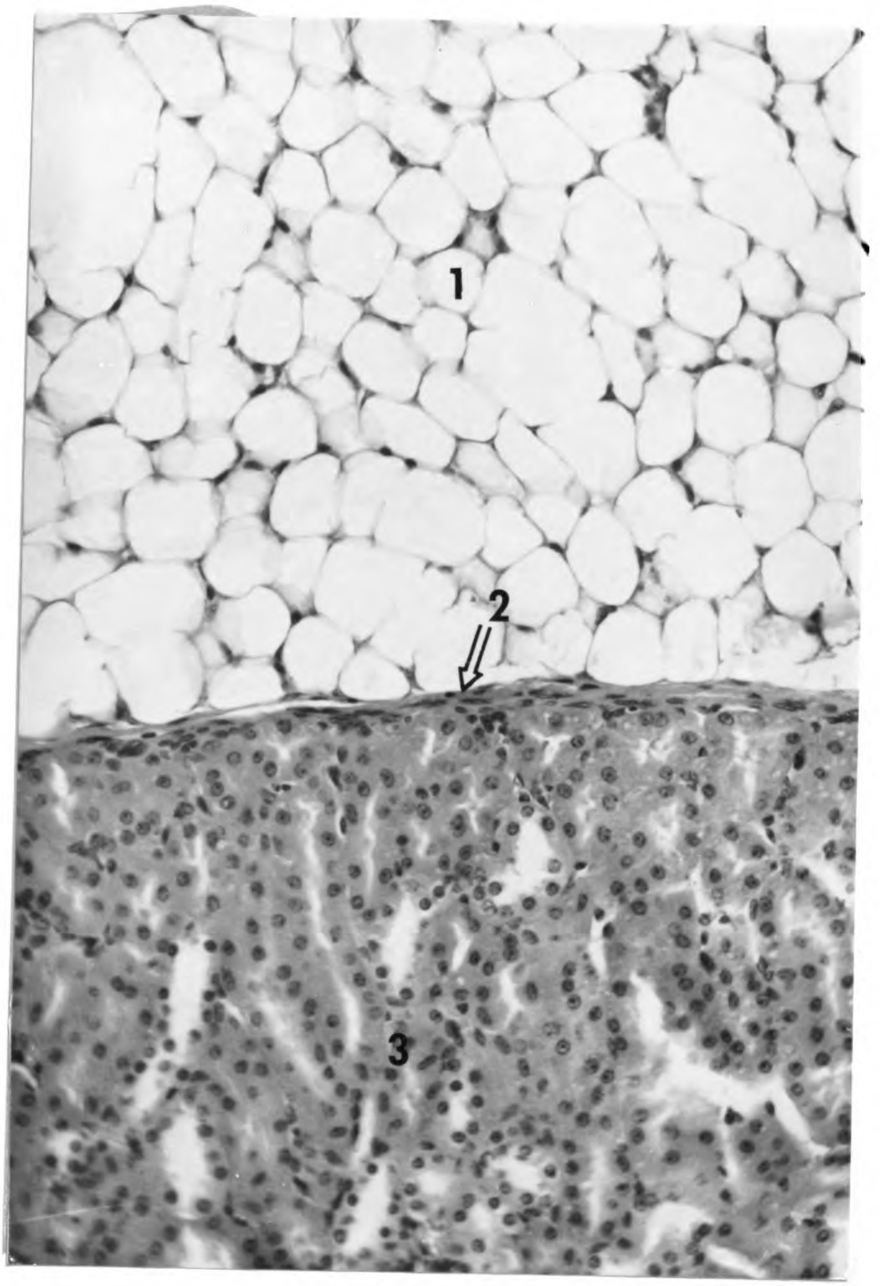
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Figure 2.--Reticular network of the kidney and its capsule. Gridley's modified reticular stain x 200

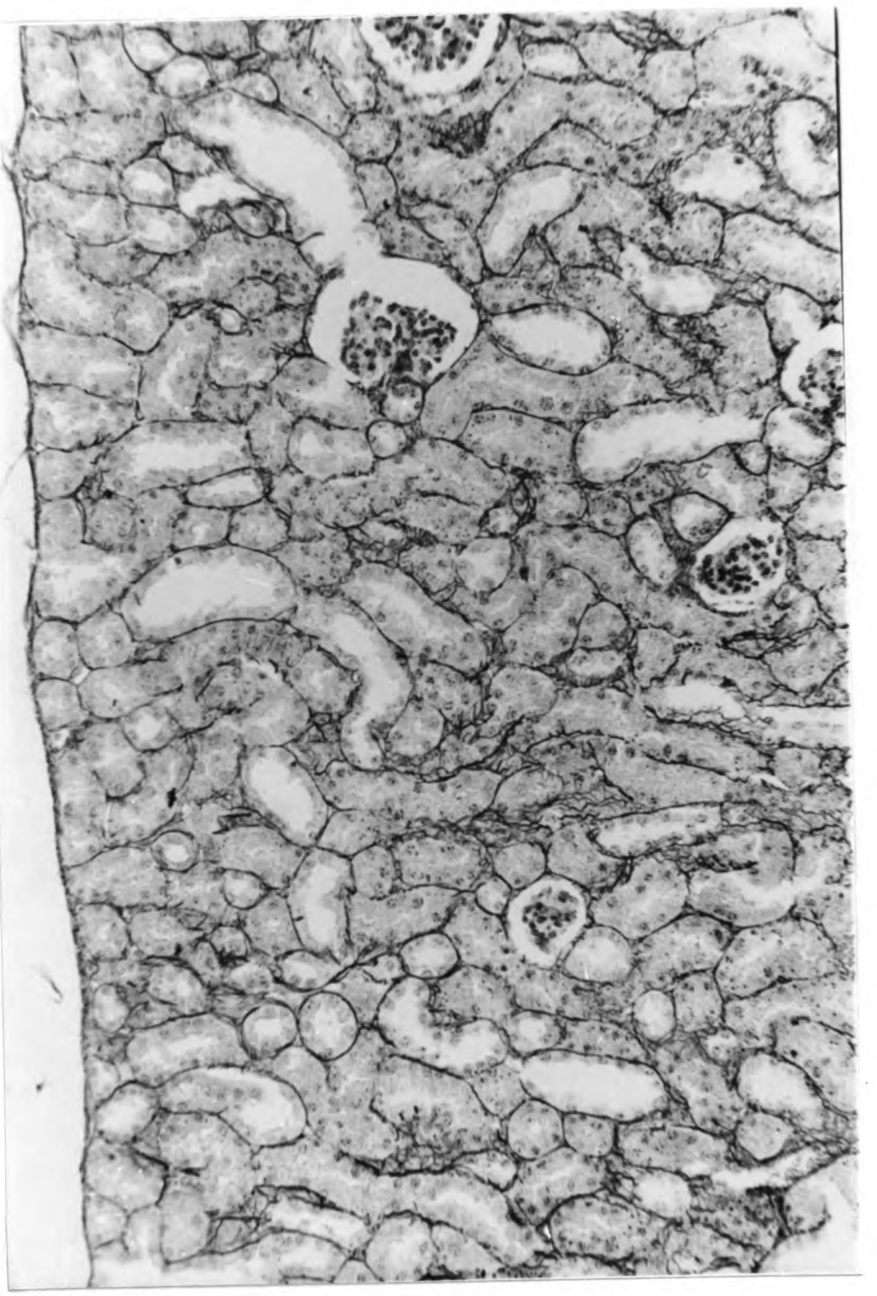


Figure 3.--Kidney cortex

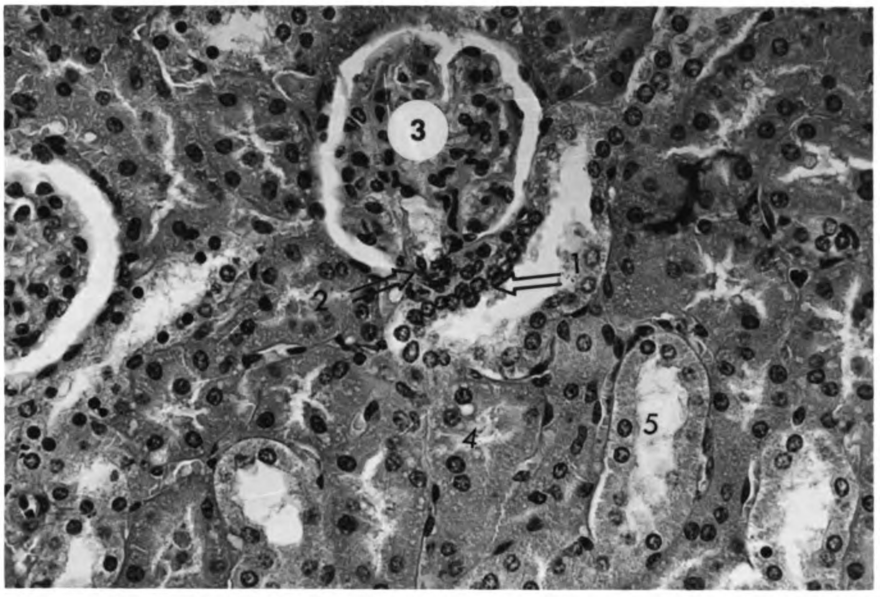
1. Macula densa
2. Juxtaglomerular apparatus
3. Glomerulus
4. Proximal convoluted tubule
5. Distal convoluted tubule

Hematoxylin and eosin x 300

Figure 4.--Kidney cortex

1. Macula densa
2. Brush border of the proximal convoluted tubule

P.A.S. x 480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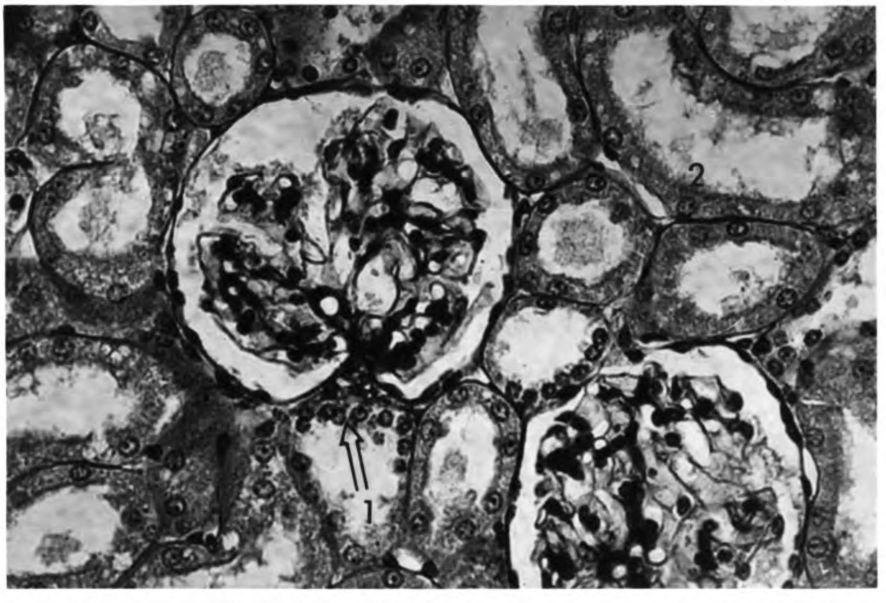
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Figure 5.--Branching arcuate artery near the cortico-medullary junction of the kidney.

1. Arcuate artery
2. Arcuate vein
3. Proximal convoluted tubule with a prominent brush border

P.A.S. x 200


3
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2

Figure 6.--Concentrations of lipid material in the proximal convoluted tubules and thick descending limbs of Henle.

The dark rim around the tubules is composed of Oil Red O positive lipid material. See next figure for higher power.

Oil Red O x 32

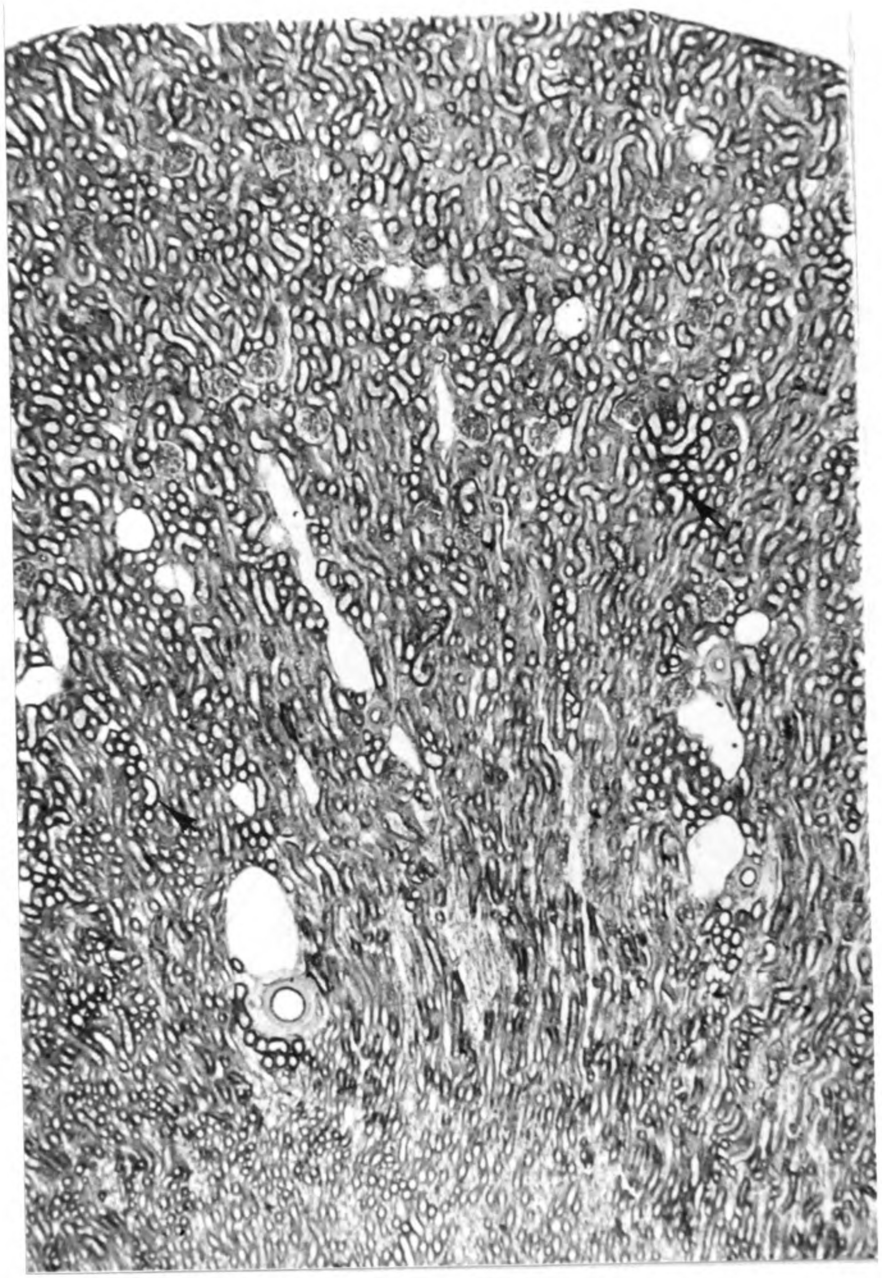


Figure 7.--Lipid droplets concentrated in the proximal convoluted tubules and thick descending limbs of Henle.

1. Proximal convoluted tubule

2. Thick descending limb of Henle

3. Thin loop of Henle

4. Thick ascending limb of Henle

Oil Red O x 500

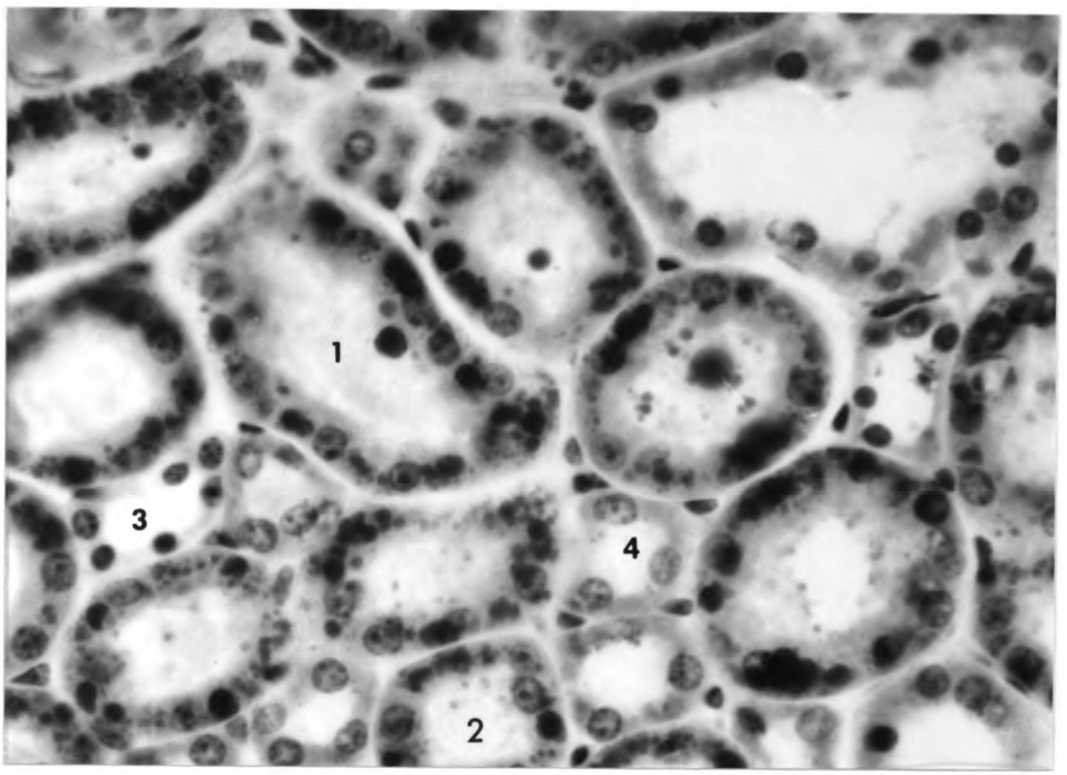
Figure 8.--P.A.S. positive material in the epithelium covering the renal crest.

1. Epithelial covering the renal crest

2. Papillary ducts

3. Lumen of the renal pelvis

P.A.S. x 800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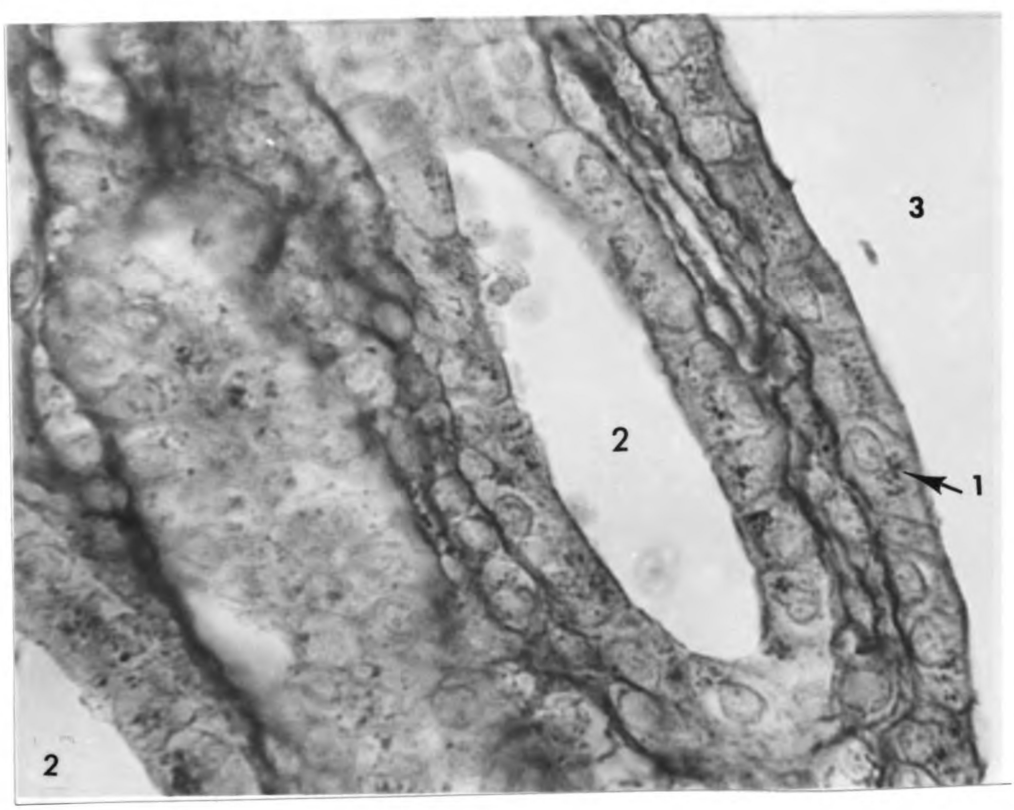
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Figure 9.--P.A.S. positive intracytoplasmic granules in the epithelium lining the papillary ducts.

1. Papillary duct

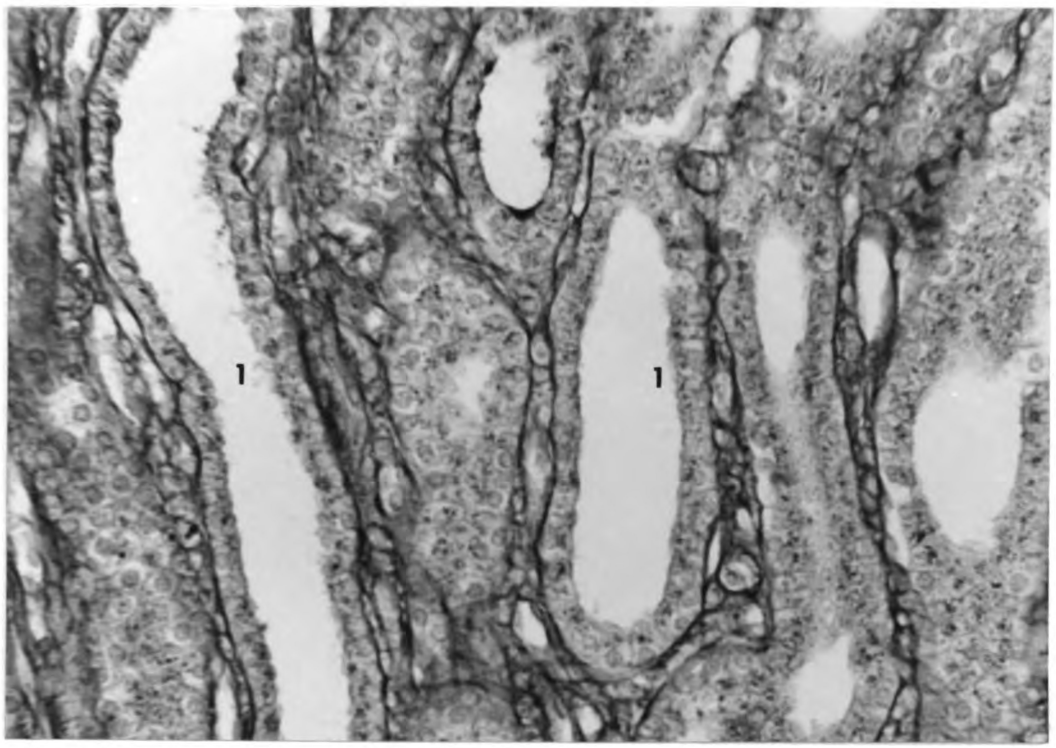
P.A.S. x 320

Figure 10.--P.A.S. positive intracytoplasmic granules in the epithelium lining the papillary ducts.

1. Papillary duct epithelium

2. P.A.S. positive granules

P.A.S. x 800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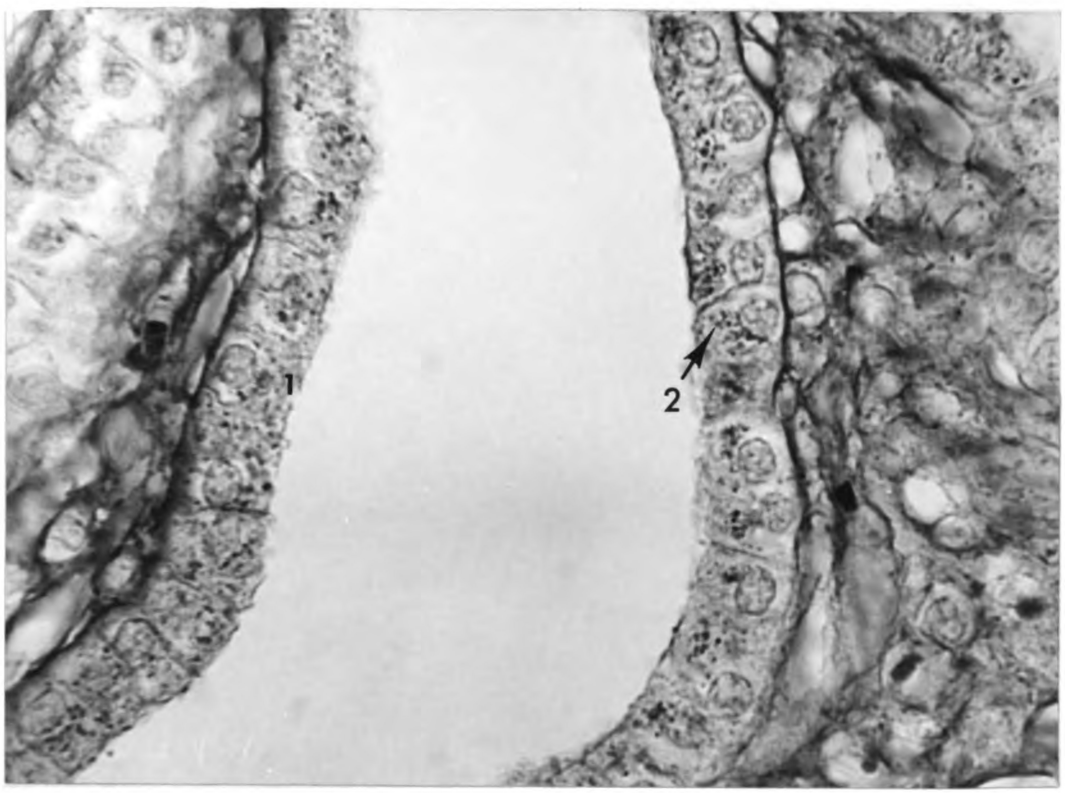
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Figure 11.--Proximal ureter with surrounding fat tunic.

1. Inner longitudinal smooth muscle layer
2. Middle circular smooth muscle layer
3. Outer longitudinal smooth muscle layer
4. Surrounding fat tunic

Hematoxylin and eosin x 200


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Figure 12.--Dense reticular network in the lamina propria submucosa of the ureter.

Gridley's modified reticular stain x 300

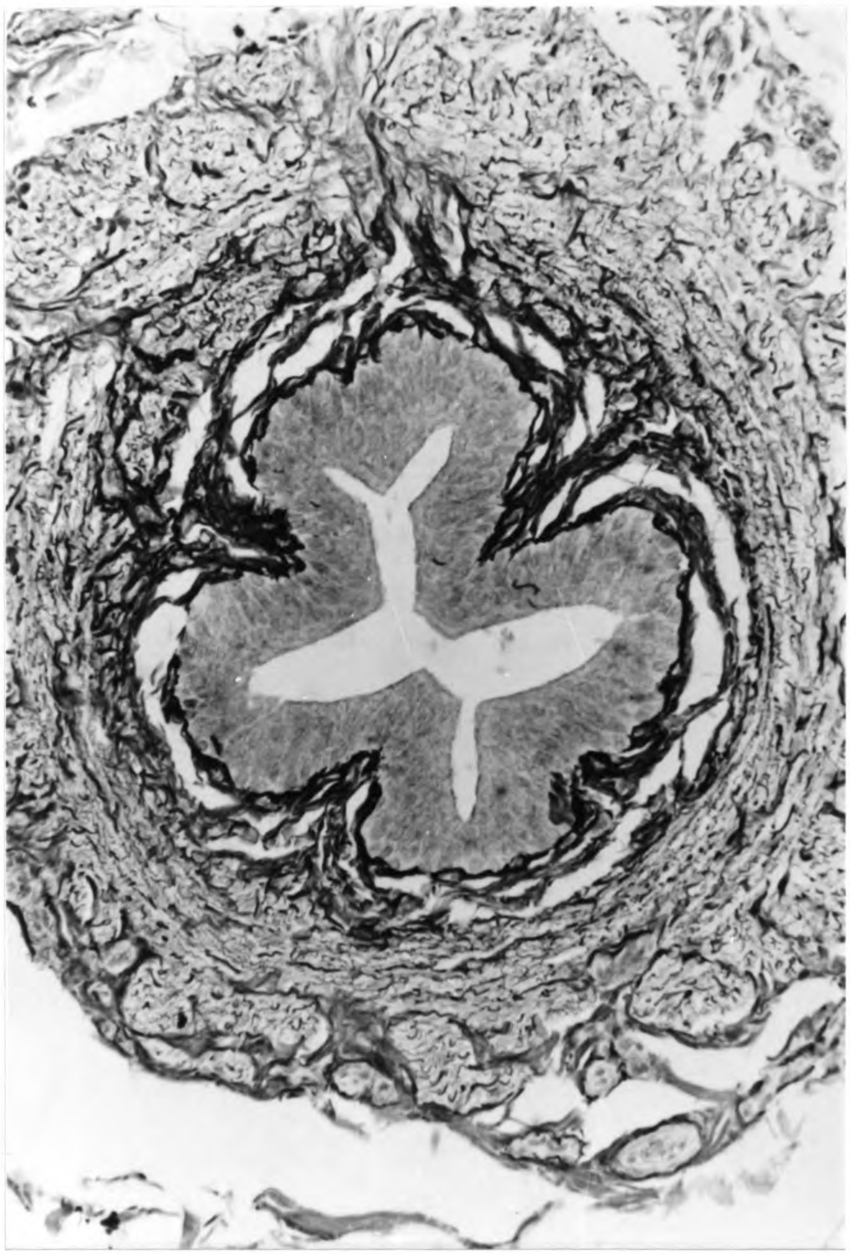

Figure 13.--Muscular arrangement of the tunica muscularis in the proximal ureter.

1. Inner longitudinal muscle layer
2. Middle circular muscle layer
3. Outer longitudinal muscle layer
4. Transitional epithelium

Hematoxylin and eosin x 320


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Figure 14.--Cross section of the middle of the ureter showing the rich vascular plexus in the adventitia and the arrangement of the tunica muscularis.

1. Lumen of the ureter
2. Lamina propria-submucosa
3. Inner longitudinal smooth muscle layer
4. Middle circular smooth muscle layer
5. Outer longitudinal smooth muscle layer
6. Vascular plexus

Hematoxylin and eosin x 200

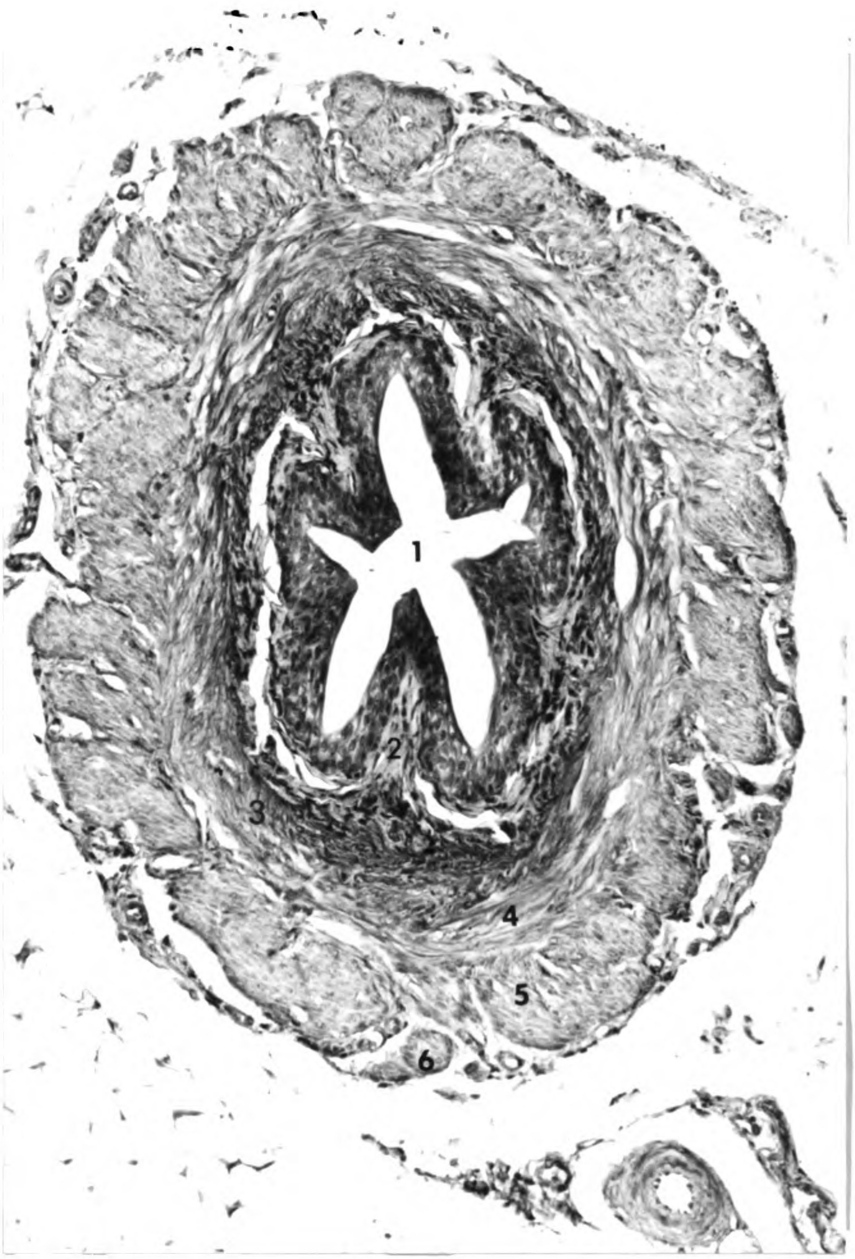
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Figure 15.--Cross section of the distal ureter showing the marked thickening of the outer longitudinal muscle layer and the diminished inner longitudinal muscle layer

1. Inner longitudinal smooth muscle layer

2. Middle circular smooth muscle layer

3. Outer longitudinal smooth muscle layer

Hematoxylin and eosin x 200

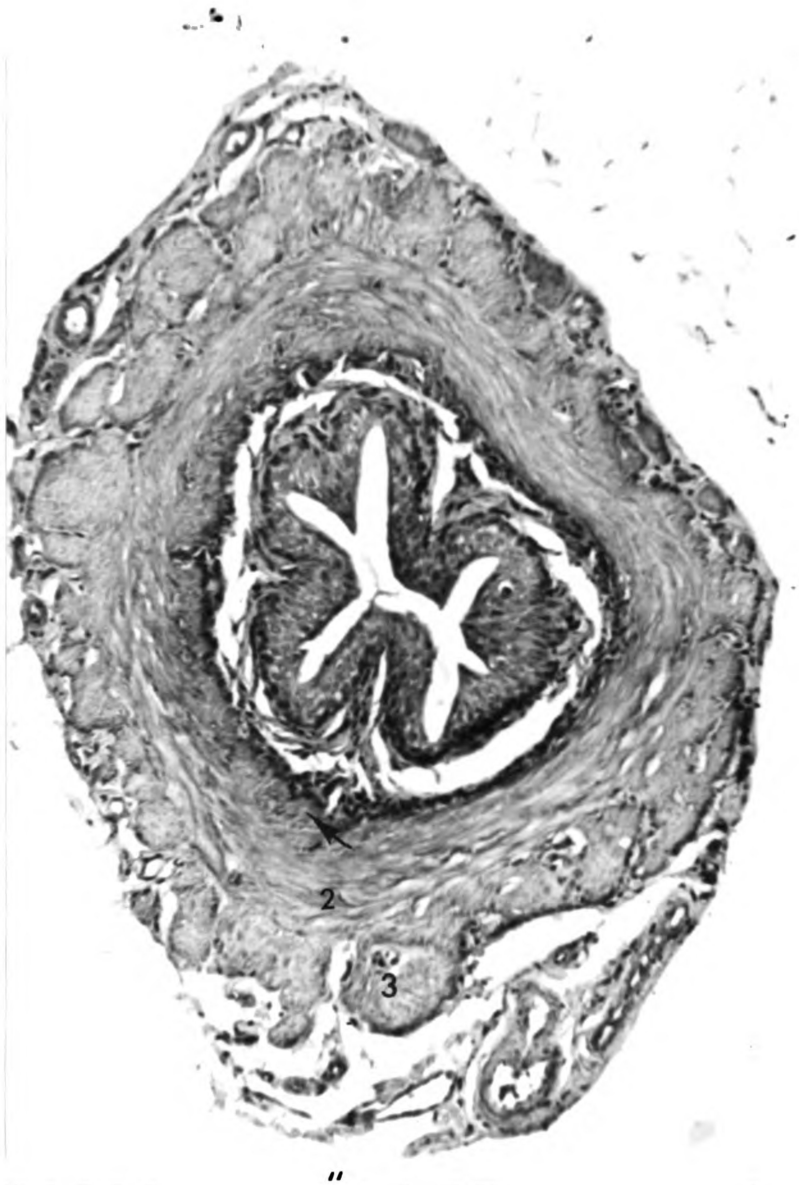
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Figure 16.--Transitional epithelium lining the ureter

1. Transitional epithelium
2. Elongated spindle shaped cell with a hyperchromatic nucleus on the lumenal border
3. Capillary plexus just below the epithelium in the lamina propria-submucosa

Hematoxylin and eosin x 1025

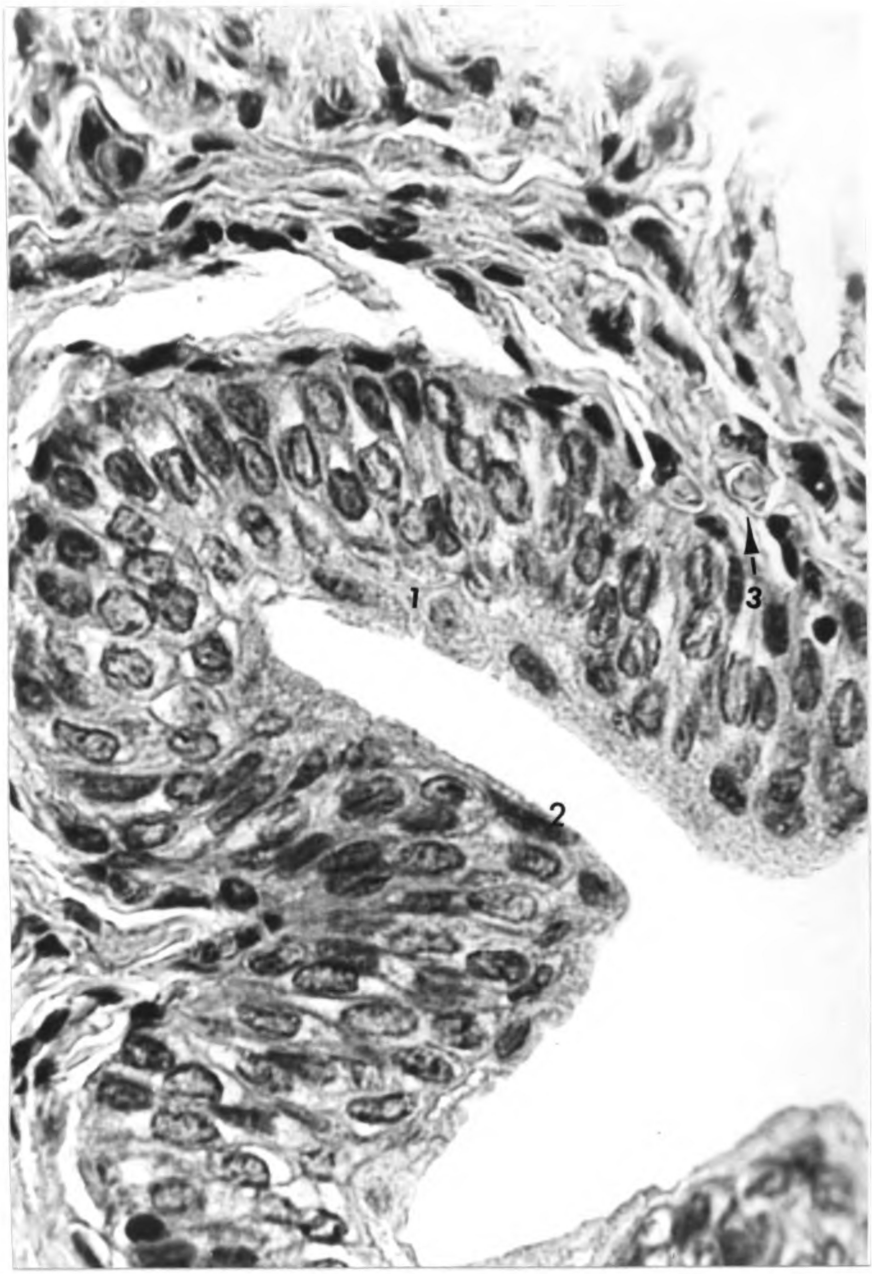
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Figure 17.--Transitional epithelium lining the ureter

1. Elongated spindle shaped cell on the lumenal surface of the ureter

Hematoxylin and eosin x 800

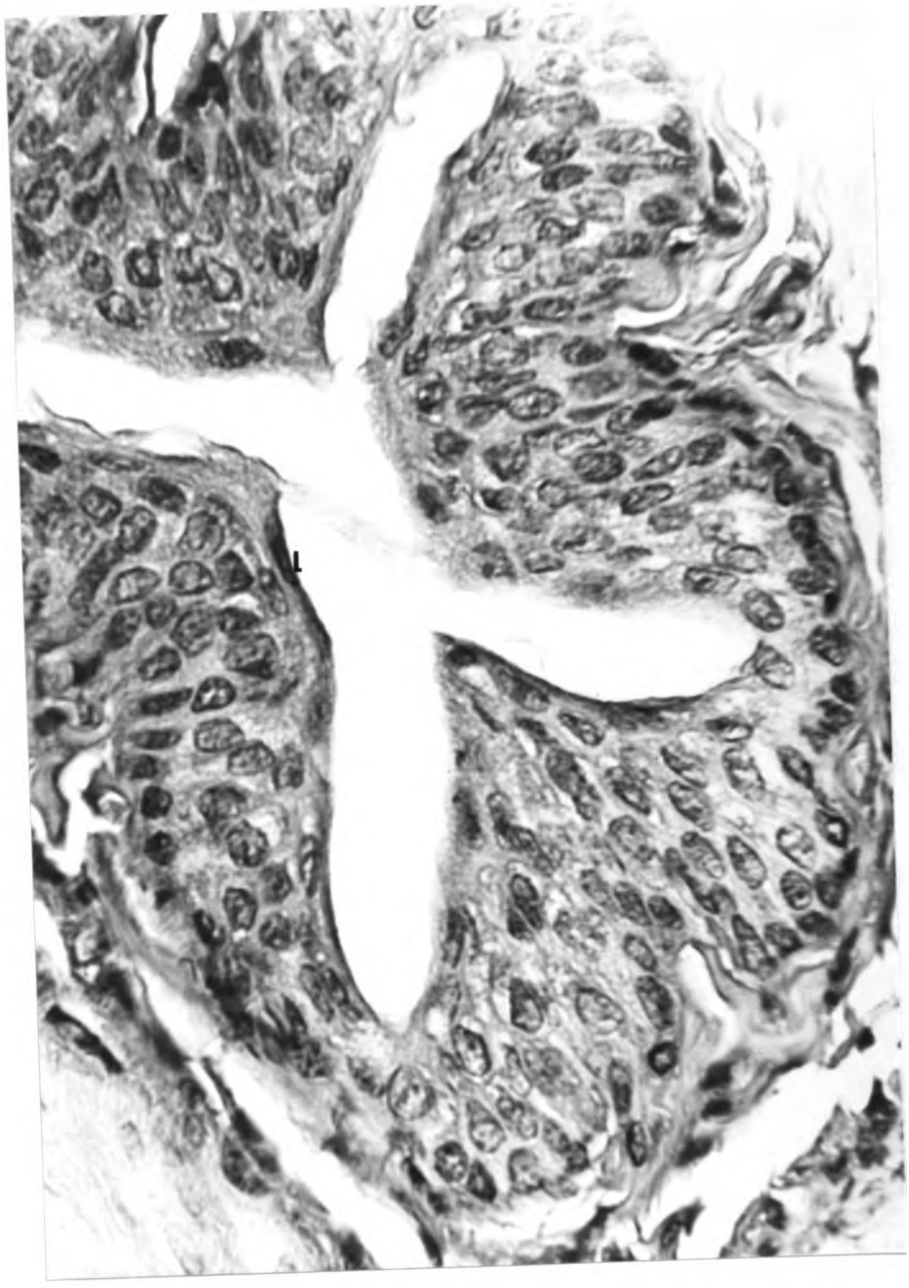

Figure 18.--Dense reticular network of the bladder

1. Bladder lumen
2. Ureter

Gridley's modified reticular stain x 32

Figure 19.--Cross section of the bladder wall showing the arrangement of the tunica muscularis. In other areas the reverse arrangement is often true.

1. Inner longitudinal smooth muscle layer
2. Outer circular smooth muscle layer
3. Muscularis mucosae

Hematoxylin and eosin x 32


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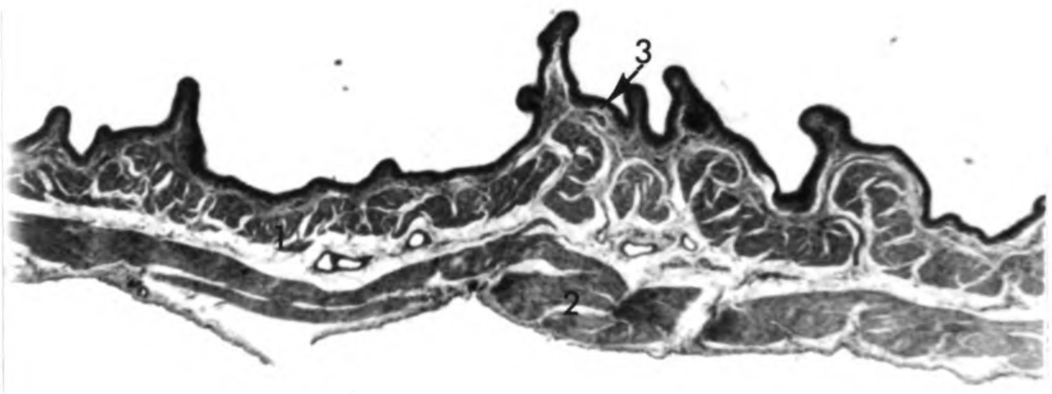
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Figure 20.--Urinary bladder mucosa

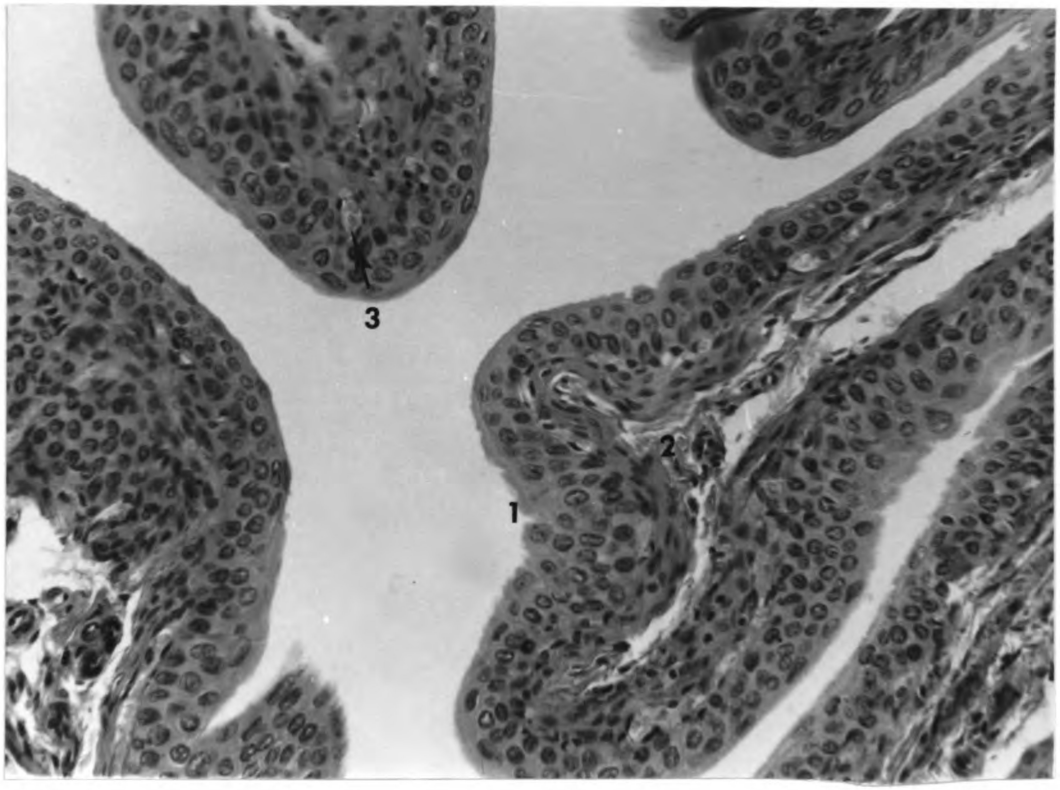
1. Transitional epithelium
2. Vascular plexus in the lamina propria
3. Capillary indenting the epithelium

Hematoxylin and eosin x 255

Figure 21.--Transitional epithelium of the bladder showing capillaries indenting its basal layers

1. Capillaries indenting the epithelium

Hematoxylin and eosin x 637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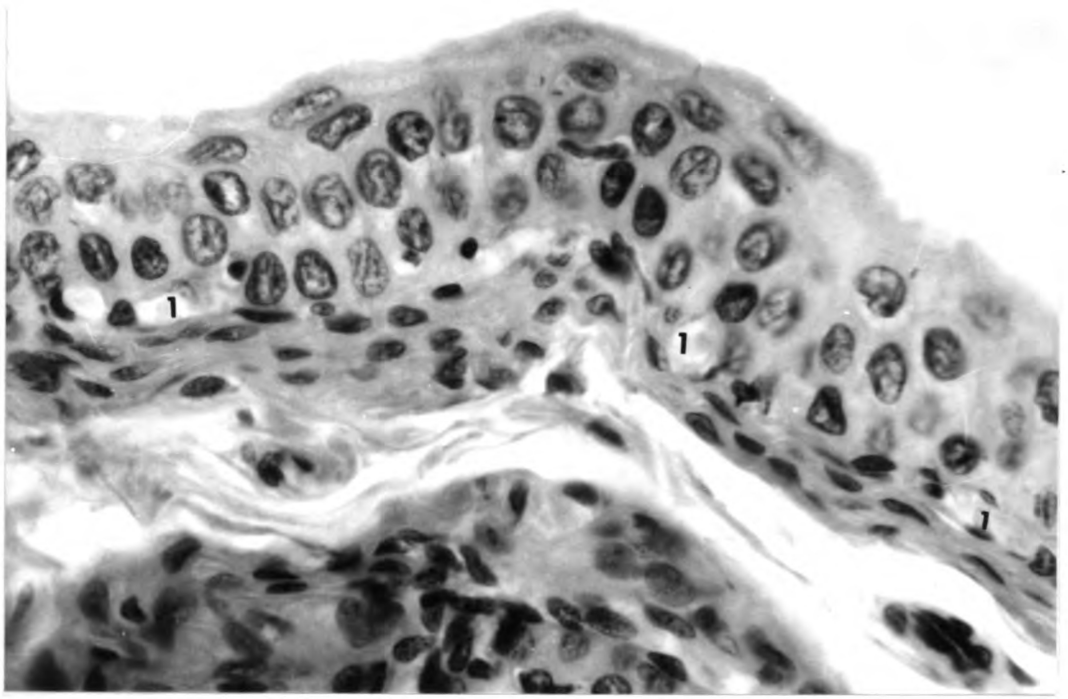
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Figure 22.--Bladder epithelium with surface cells about to be sloughed

Hexatoxylin and eosin x 500

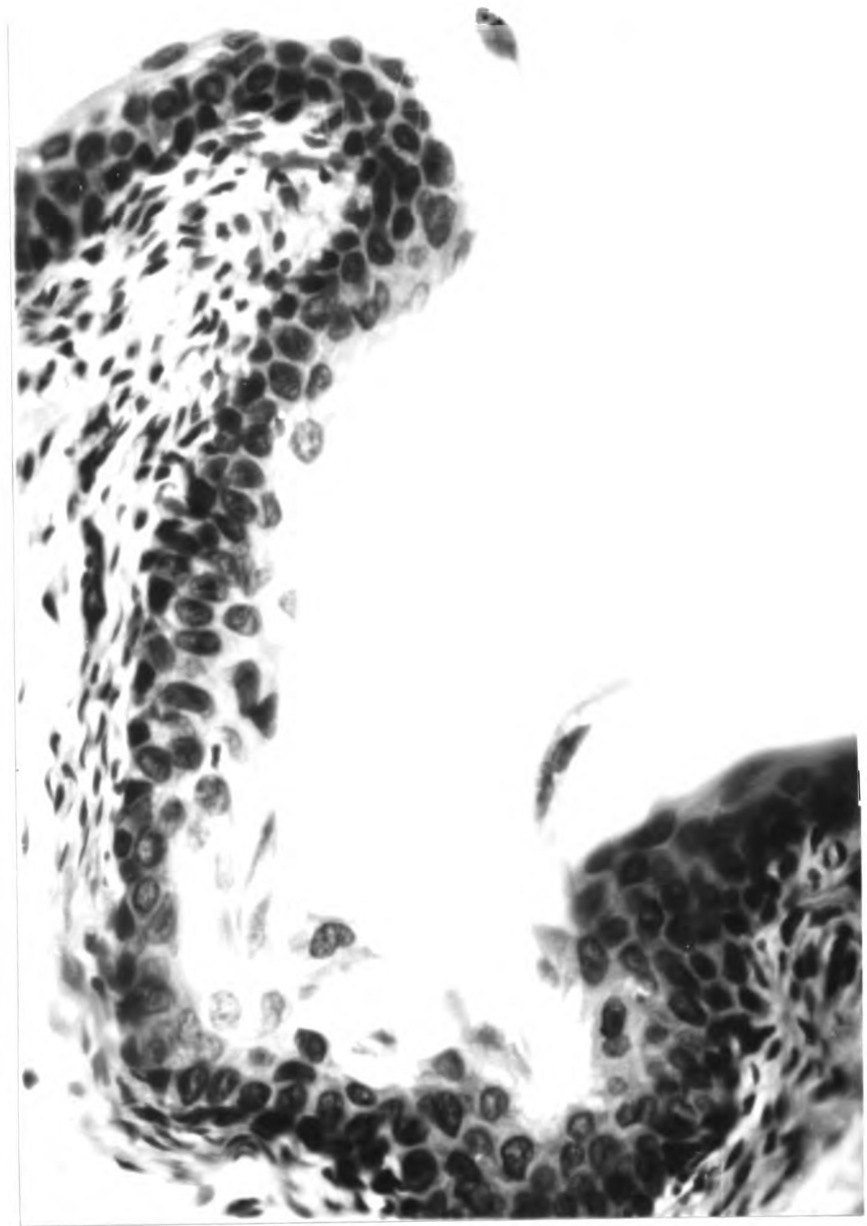


Figure 23.--Cross section of the outer bladder wall

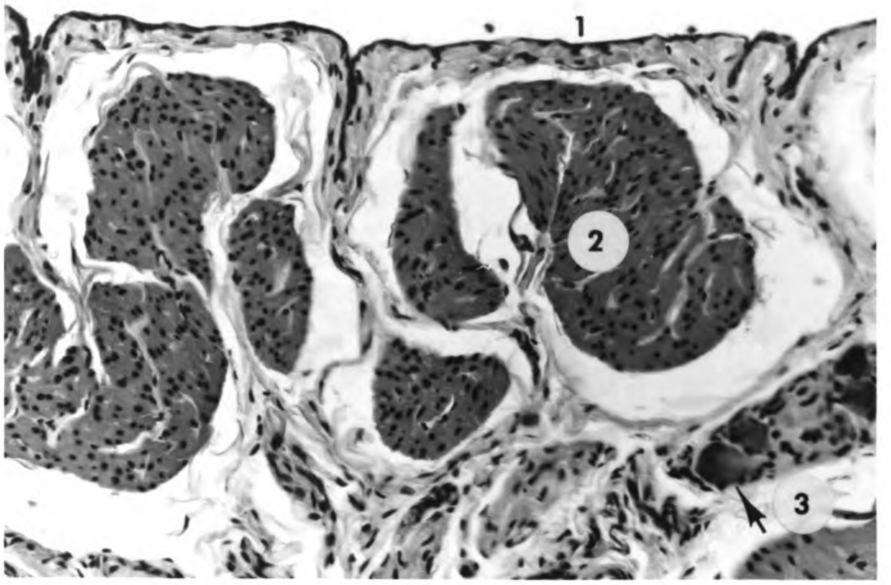
1. Adventitia (serosa)
2. Tunica muscularis
3. Autonomic ganglion

Hematoxylin and eosin x 75

Figure 24.--Cross Section of the prostatic urethra

1. Lumen of the prostatic urethrae
2. Ductus deferens

Hematoxylin and eosin x 19.2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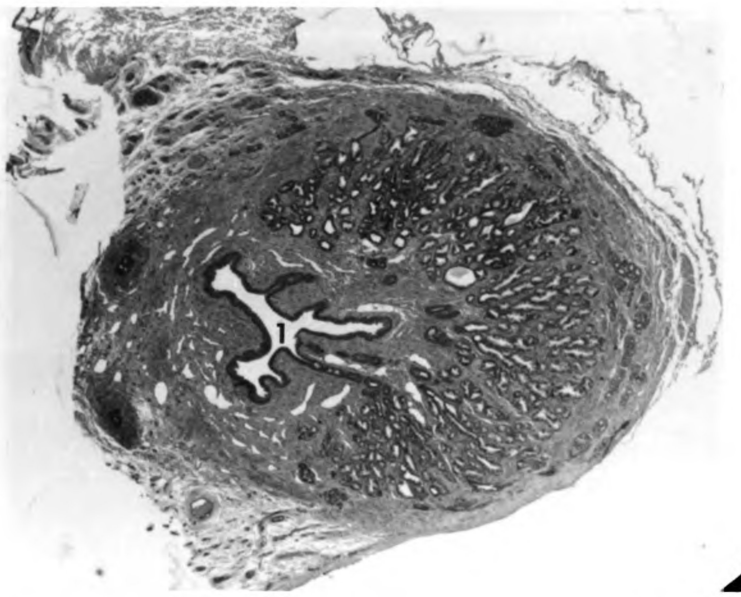
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Figure 25.--Prostatic duct opening into the urethral lumen

1. Prostatic duct
2. Urethral lumen

Hematoxylin and eosin x 200


1
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Figure 26.--Cavernous spaces in the lamina propria of the prostatic urethra

1. Cavernous spaces

Hematoxylin and eosin x 200

Figure 27.--Elastic fibers in the lamina propria of the prostatic urethra

1. Elastic fibers

Weigert VanGieson x 800

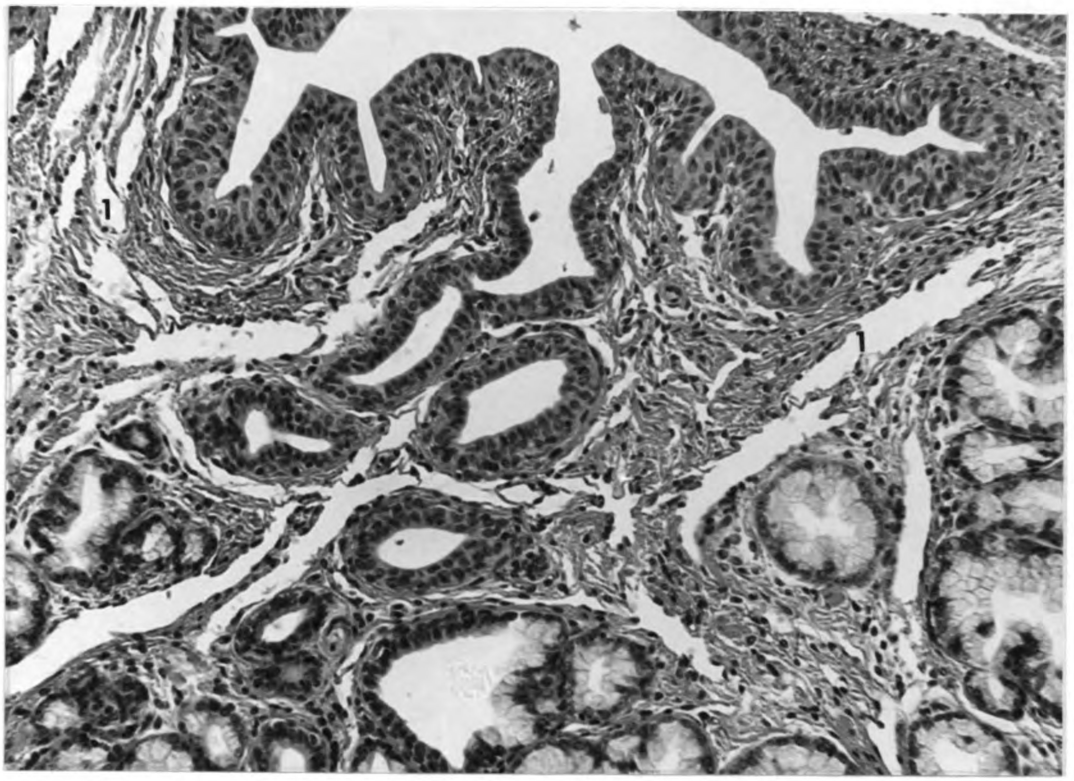
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Figure 28.--Prostatic utriculus opening on the colliculus seminalis of the prostatic urethra

1. Prostatic utriculus

2. Colliculus seminalis

Hematoxylin and eosin x 200

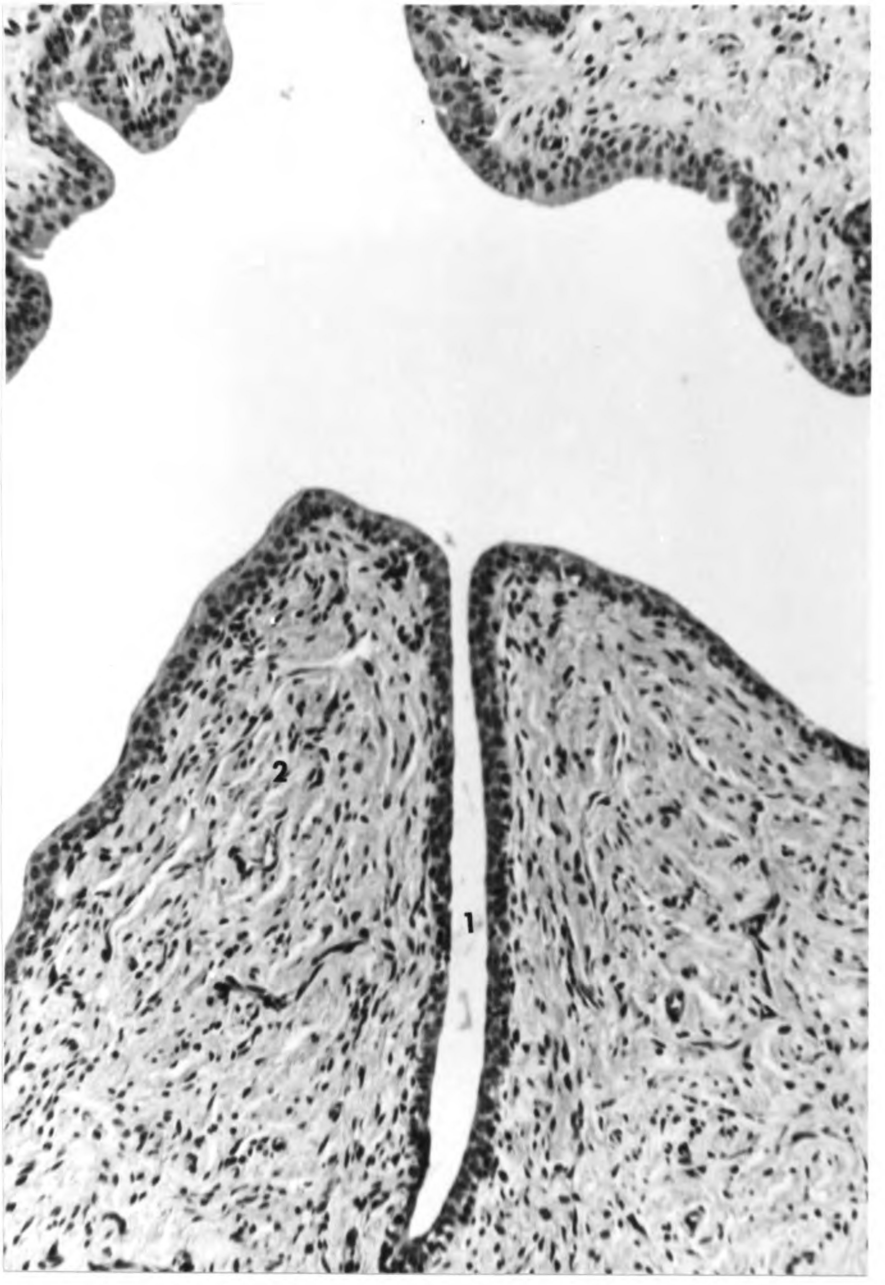
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Figure 29.--Cross section of the membranous urethra

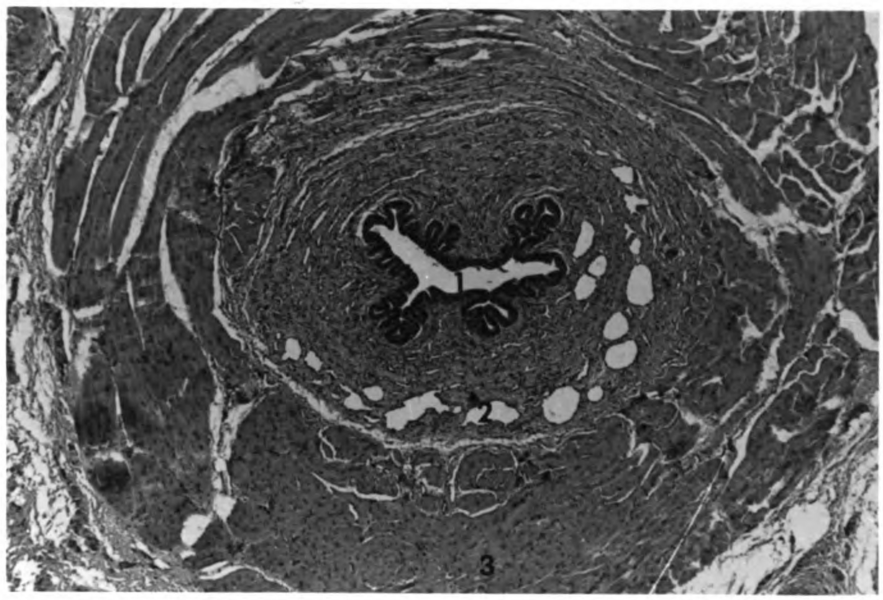
1. Urethral lumen
2. Cavernous spaces
3. Skeletal urethral muscle

Hematoxylin and eosin x 30

Figure 30.--Mucosa of the membranous urethra

1. Urethral lumen

Hematoxylin and eosin x 120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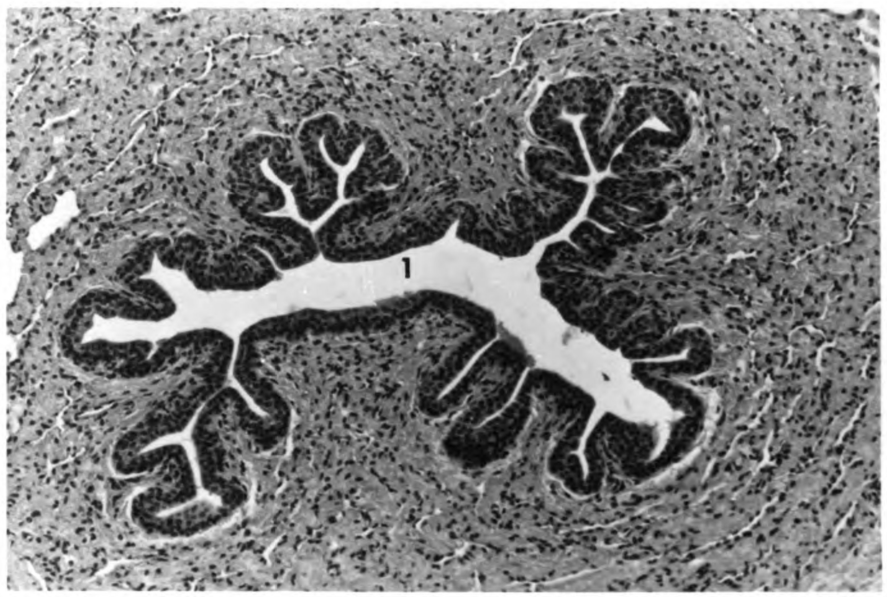
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Figure 31.--Epithelial lining of the membranous urethra
Hematoxylin and eosin x 200

Figure 32.--Cross section of the membranous urethra showing the extensive network of elastic fibers in the lamina propria

1. Lamina propria

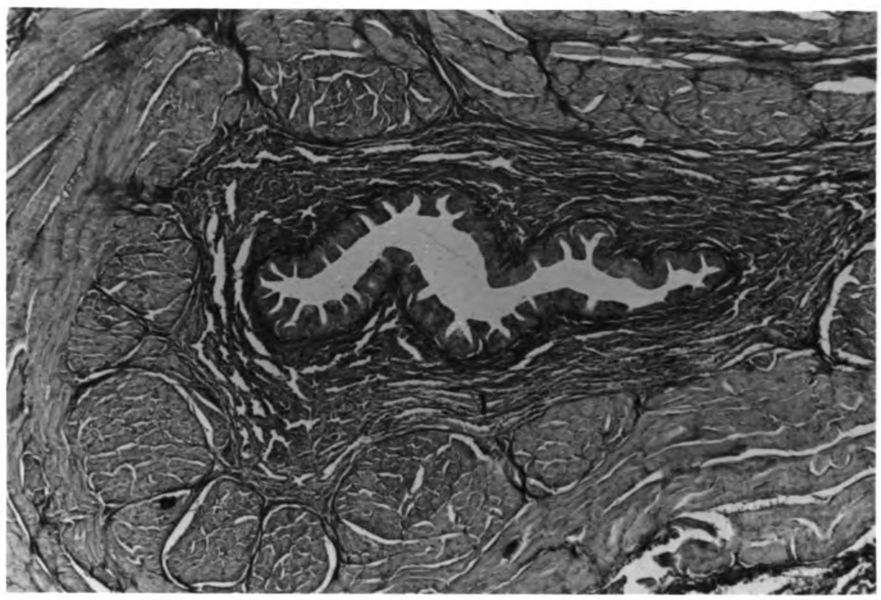
Weigert VanGieson x 30

Figure 33.--Cross section of the membranous urethra showing the extensive network of elastic fibers in the lamina propria

1. Lamina propria

2. Elastic fibers

Weigert VanGieson x 480



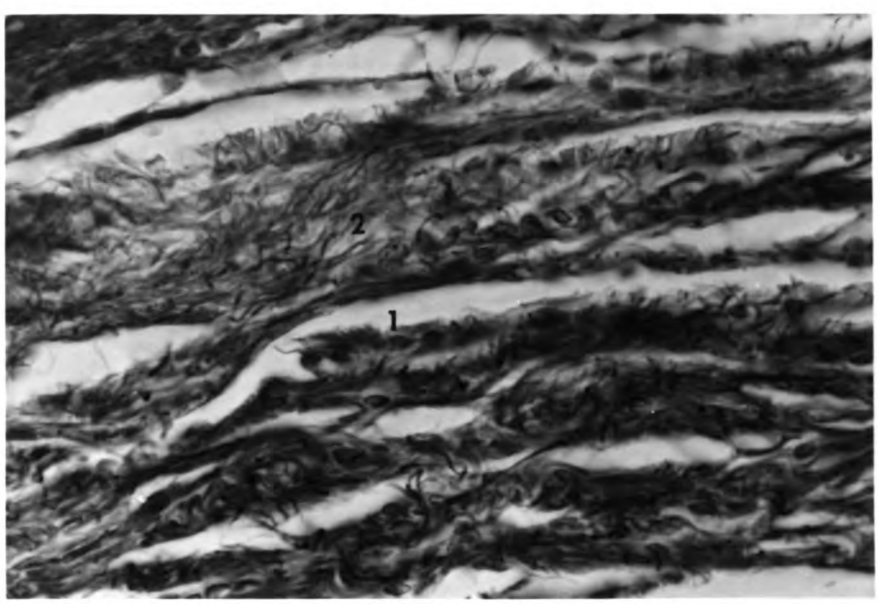

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Figure 34.--Cross section of the proximal penile urethral mucosa

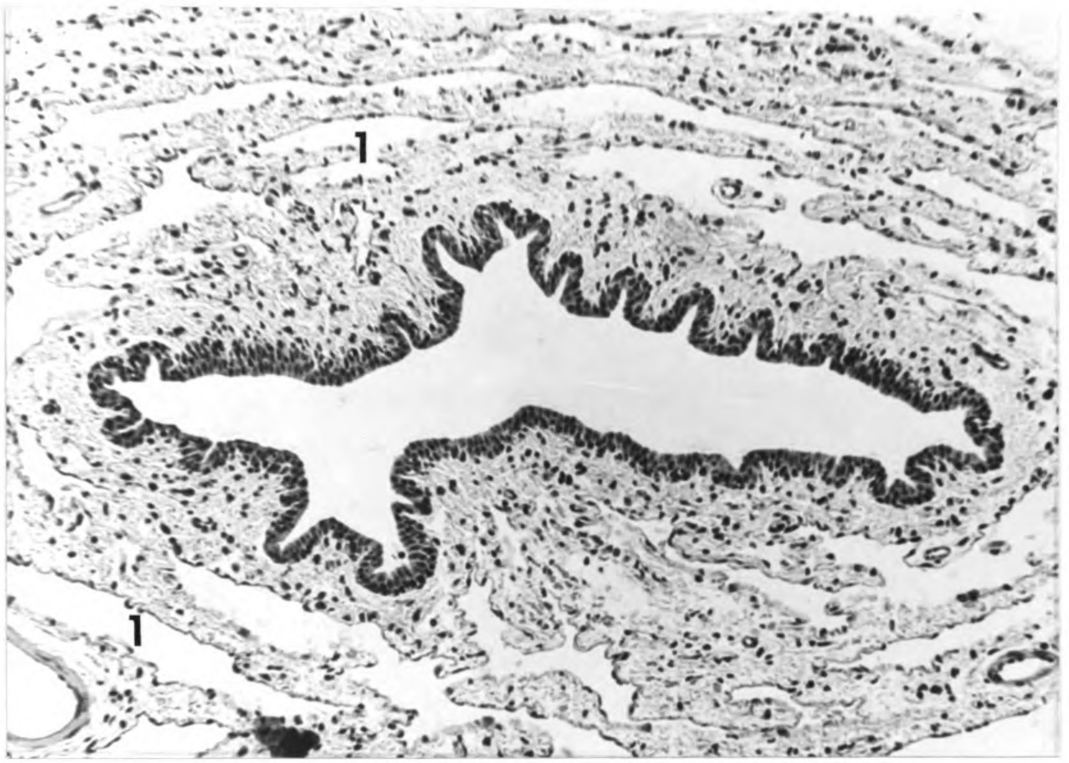
1. Numerous venous sinuses in the lamina propria

Hematoxylin and eosin x 200

Figure 35.--Epithelial lining of the proximal penile urethra

1. Stratified columnar epithelium
2. Intraepithelial nest of mucous cells
3. Lacunae of Morgagni

Hematoxylin and eosin x 500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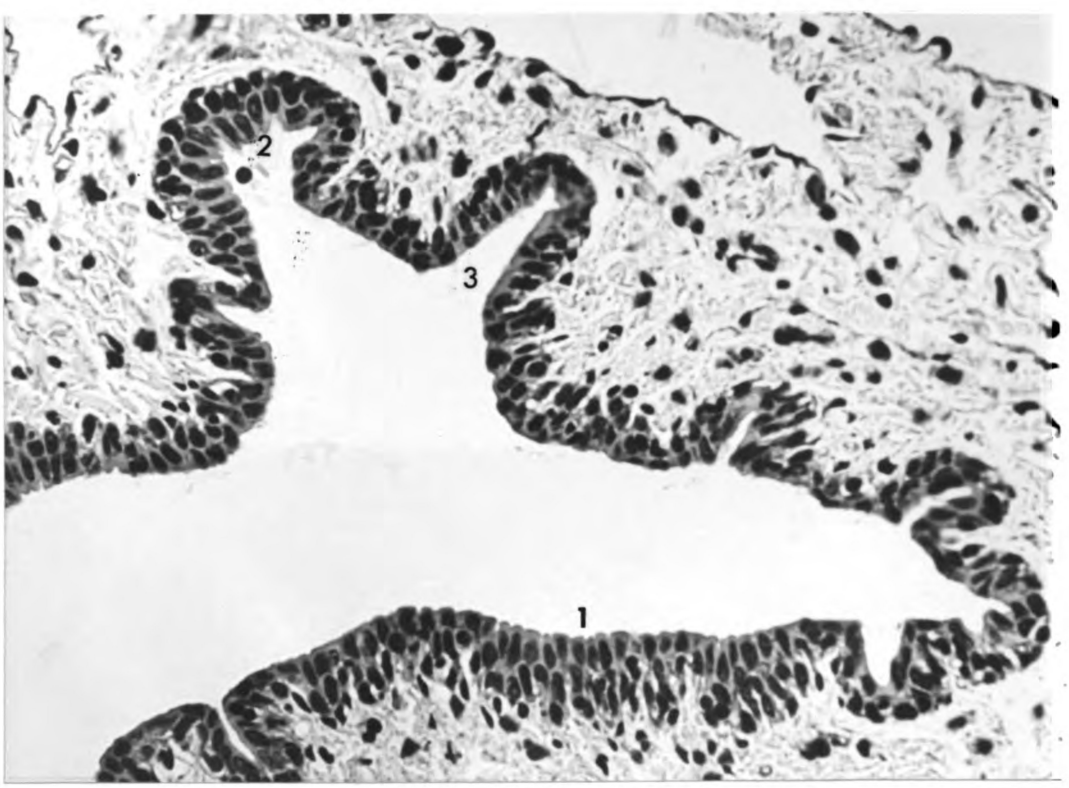
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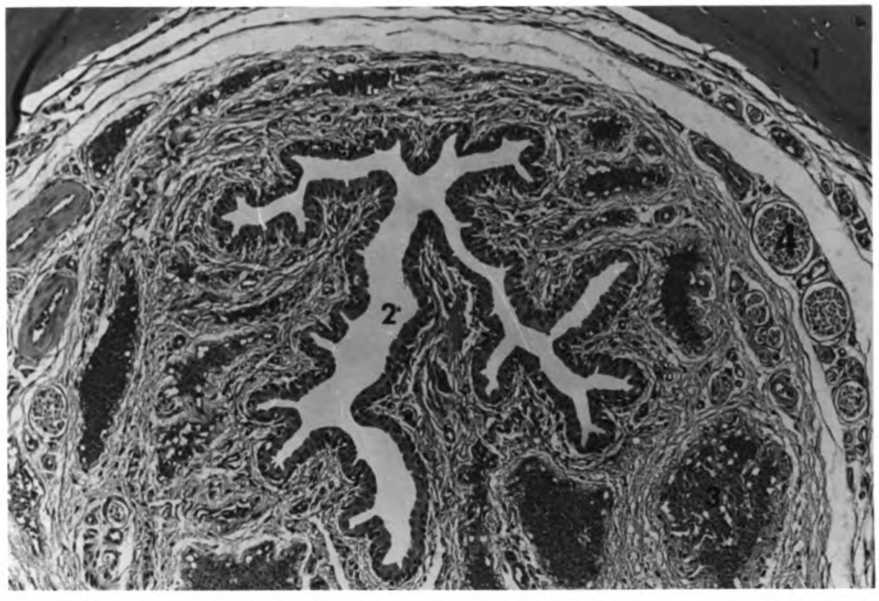
Figure 36.--Cross section of the penile urethra near the external urethral orifice

1. Os penis
2. Urethral lumen
3. Venous sinuses engorged with blood
4. Nerve plexus

Hematoxylin and eosin x 30

Figure 37.--Epithelial lining of the penile urethra near the external urethral orifice

Hematoxylin and eosin x 480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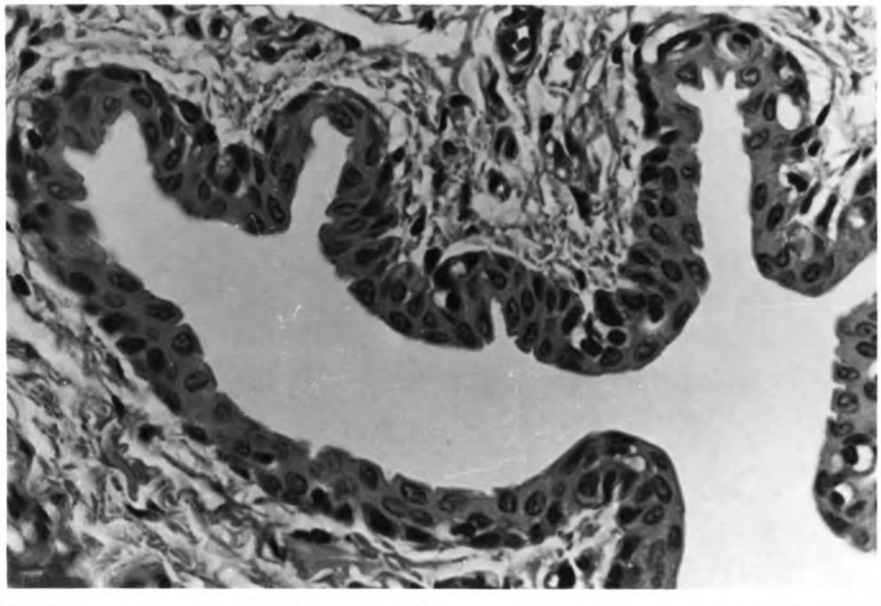


Figure 38.--Cross section of the female urethra showing the dense reticular network in the lamina propria-submucosa

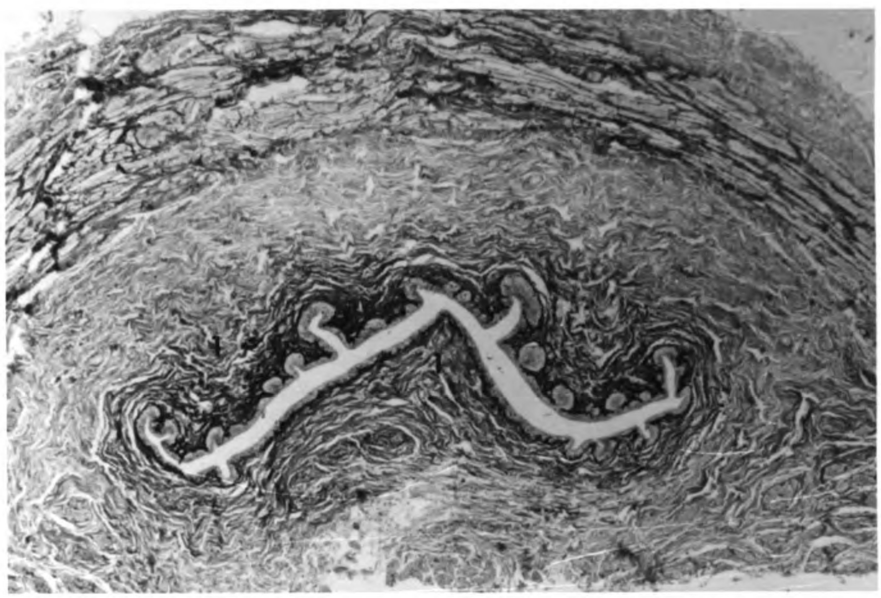
1. Reticular fibers

Gridley's modified reticular stain x 30

Figure 39.--Cross section of the proximal female urethra

1. Skeletal urethral muscle
2. Urethral lumen
3. Lacunae of Morgagni

Hematoxylin and eosin x 30



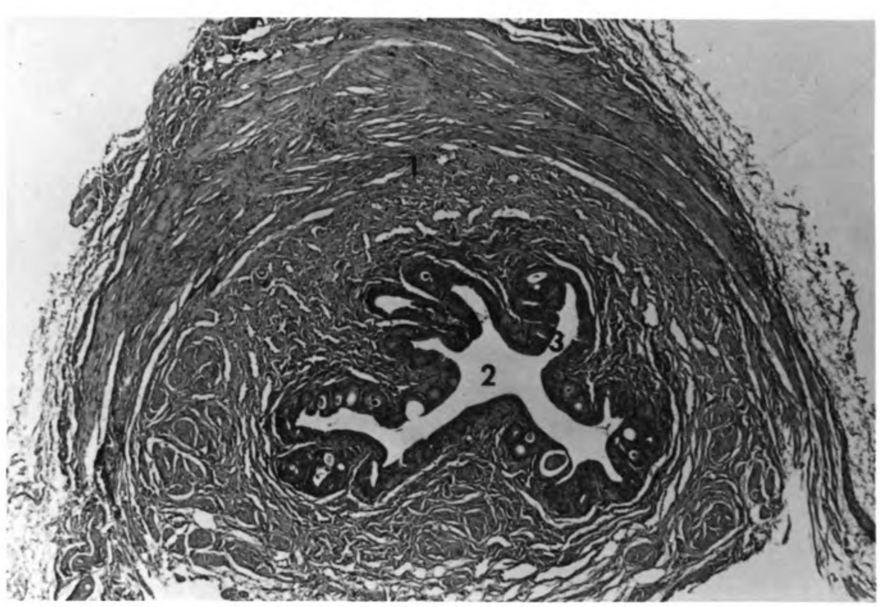

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Figure 40.--Female urethral epithelium (mid portion)

1. Lacunae of Morgagni
2. Intraepithelial nest of mucous glands

Hematoxylin and eosin x 120

Figure 41.--Nests of serous glands located deep in the submucosa and between the bands of the skeletal urethral muscle of the female urethra

1. Nests of serous glands
2. Skeletal urethral muscle
3. Submucosa

Hematoxylin and eosin x 154


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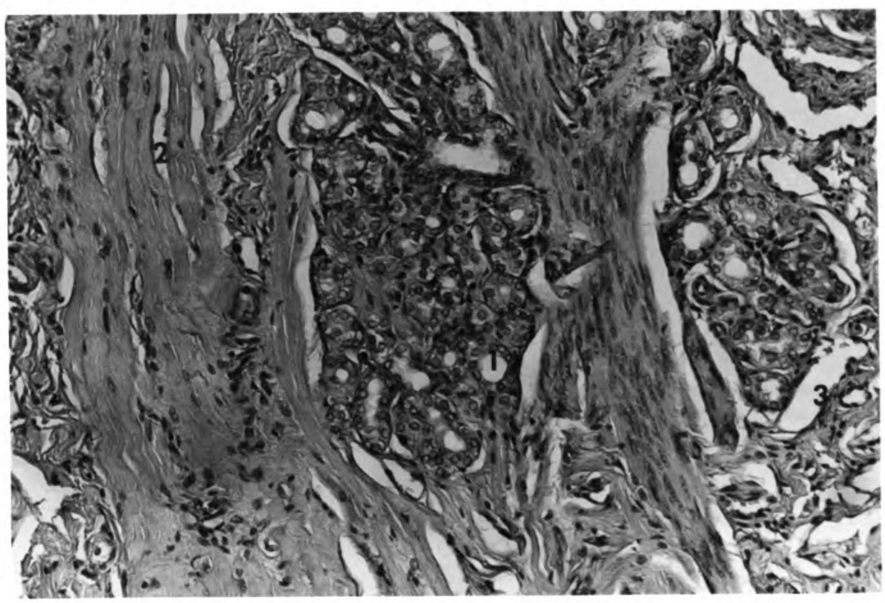
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Figure 42.--Intraepithelial cysts in the female urethral epithelium

1. Intraepithelial cyst
2. Lacunae of Morgagni
3. Nests of mucous cells

Hematoxylin and eosin x 120

Figure 43.--Stratified sqamous epithelium lining the distal female urethra

Hematoxylin and eosin x 300


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