

Co and Benjamin  
Laboratory Manual in Animal Histology  
2<sup>nd</sup> Ed

# **Laboratory Manual in Animal Histology (Biology 134)**



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## EXERCISE 11: THE EXCRETORY SYSTEM

### Introduction

The excretory system is composed of paired kidneys, the ureters, urinary bladder, and the urethra. The main function of the kidney is the removal of nitrogenous wastes in the form of urine.

### Objectives

At the end of the exercise, the students should be able to:

1. identify the histological properties of the different organs of the excretory system; and,
2. correlate their structures with their functions in forming a hypertonic urine.

### The Parts of the Excretory System

**A. Kidneys** – a pair of bean-shaped organs located retroperitoneally. The outer region is called the cortex while the inner region is called the medulla. Inside are millions of nephrons which are the structural and functional units of the kidneys. Focus under HPO and identify the following components of the nephrons.

**1. Renal Corpuscles** - small, round bodies that are dark and scattered all over the kidneys. They are composed of:

- ❖ **Glomerulus** – a small cluster of capillaries that are highly basophilic. It has two poles:
  - **Vascular pole** – region where the afferent and efferent arterioles are located.
  - **Afferent arteriole** – small branch of renal artery which brings blood into the glomerulus. Near the entry point into the glomerulus, the muscle layer of this arteriole has been modified and consists of Juxtaglomerular cells. They are somewhat cuboidal with basophilic cytoplasm.
  - **Efferent arteriole**- formed by the union of the capillaries in the glomerulus. This vessel conveys the filtrate to the PCT.
- ❖ **Bowman's Capsule** – a double layered membrane enclosing the glomerulus.
- ❖ **Podocytes** - large basophilic cells that are intimately associated with the capillaries. They constitute the inner visceral layer of the Bowman's capsule. Their fine

processes are the ones responsible for the filtration of the blood.

- ❖ Parietal membrane – outer covering of the glomerulus composed of simple squamous epithelium. Between this and the glomerulus is a thin, clear space.

**2. Renal Tubules** – round or oval structures surrounding the renal corpuscles. There are two types:

- ❖ **Proximal Convoluted Tubules (PCT)** – lined with simple cuboidal epithelium with prominent brush border. They are more numerous than the other type but the nuclei per tubule are fewer. The lumen may be large, star-shaped or slit-like.
- ❖ **Distal Convoluted Tubules (DCT)** – have the same epithelium but indistinct brush border. They are usually smaller, fewer and more acidophilic than PCT. Their lumen is somewhat round, smaller and without debris.
- ❖ **Macula Densa** – dense aggregation of nuclei of columnar cells that are actually part of the DCT located near the efferent arteriole. This appears basophilic owing to the tight packing of the nuclei.
- ❖ **Loops of Henle** – U-shaped structures continuous with the PCT and DCT. These are mostly found in the juxtamedullary zone and extend deep into the medulla. They are composed of two parts:
  - **Descending loop of Henle** – the continuation of the PCT with short thick segment and a long thin segment continuous with the ascending loop of Henle. The thick segment is composed of simple cuboidal epithelium while the thin segment is composed of simple squamous epithelium.
  - **Ascending loop of Henle** – has a long ascending segment and a short thick segment. The lining of the loop is similar to that of the descending loop of Henle. Both have a spherical appearance under the microscope.

**3. Collecting Tubules** – consist of simple cuboidal epithelium in smaller tubules and columnar epithelium in larger tubules and ducts. They are located in the medullary region. The cells appear very light with clear boundaries between them. The apical surface of the cells tends to be convex, while the basal part contains round euchromatic nucleus.

**B. Urinary Bladder** – storage organ which exhibit identical histology as the ureter and the renal pelvis. It is composed of four main layers:

1. **Mucosa** - composed of transitional epithelium which vary in thickness depending upon the physiological state of the organ. There are 2-3 layers of cells if the bladder is distended and is seen as a thin epithelium. However, if the organ is empty or contracted, there are 5 -8 cell layers. The lamina propria consists of connective tissue fibers and diffused lymphoid tissue.
2. **Submucosa** - seemingly absent but the deeper layers have loose and more elastic components. This is the one responsible for the longitudinal folding of the mucosa and is seen as stellate in ureter and thick irregular folds in the urinary bladder.
3. **Muscularis** – consists of three layers of smooth muscle bundles: inner longitudinal, middle circular and outer longitudinal. They are irregularly disposed with no definite boundary among them. The thickest layer is the middle circular muscles.
4. **Adventitia** - composed of loose connective tissue with many large blood vessels and lymphatic vessels. Nerve plexuses and ganglia are also present. Serosa is found on the superior surface of the bladder.

**C.Urethra** – in **male**, it is quite long and consists of three parts: prostatic, membranous and cavernous urethrae. The last part extends through the penis and surrounded by the corpus cavernosum urethra. It has three layers:

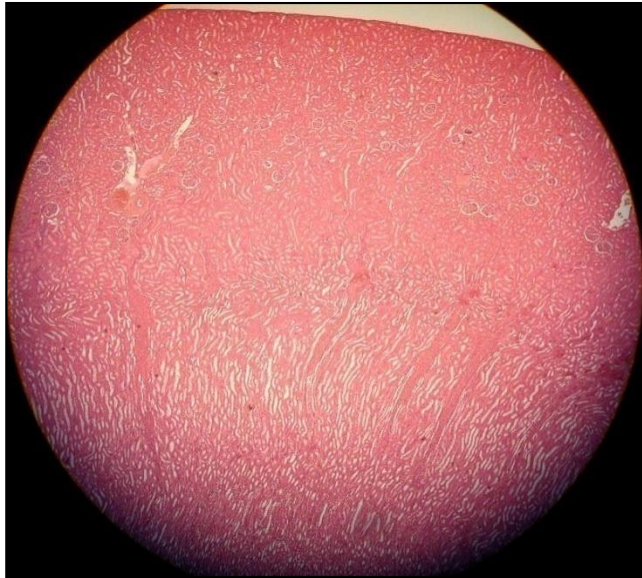
1. **Mucosa** - lined with stratified or pseudostratified columnar epithelium and patches of stratified squamous epithelium. Interposed among the epithelial cells are cluster of mucous cells that are glandular in function. On the surface of the mucous membrane, there are large recesses called Lacunae of Morgagni. The lamina propria consists of numerous elastic fibers and veins. Deep into the lamina are branching mucus-secreting cells known as the Glands of Littre.
2. **Muscularis** - consists of two layers of smooth muscles: inner longitudinal and outer circular muscles. The internal sphincter is formed from thickened circular muscle layer at the neck of the bladder.
3. **Adventitia** - the cavernous part is surrounded by erectile tissues and a dense outer sheath of connective tissues.

**The Female Urethra** - about 2 inches, much shorter than that of male urethra. Consists of three layers:

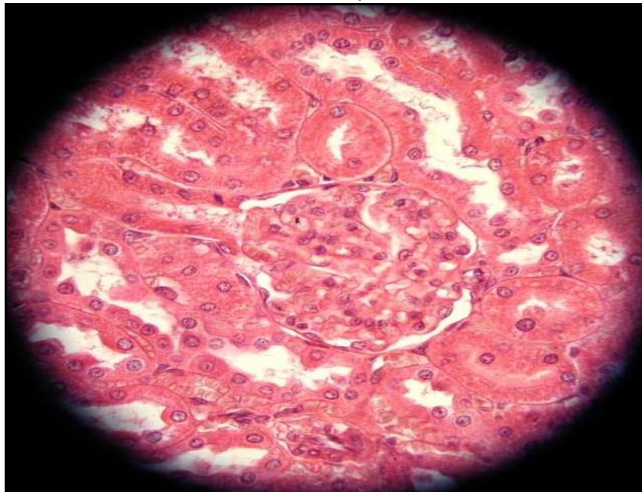
1. **Mucosa** - usually transitional epithelium or stratified columnar epithelium near the bladder, but mostly stratified squamous epithelium in the intermediate areas. The lumen appears wavy or crescentic.
2. **Urethral Glands** - nest of mucus cells and invaginated mucosal epithelium are also observed.
3. **Lamina propria** – consists of loose connective tissue with abundant elastic fibers and nerve plexuses.
4. **Muscularis Externa** - very thick layer of smooth muscles subdivided into an inner longitudinal and outer circular layers. The latter form the involuntary sphincter. Outside this, the bundle of circular skeletal muscle fibers forms a constriction, the Constrictor urethra near the outlet of the urethra.

**5. Adventitia** - appears indistinct as it fused with the surrounding structures. Nerves and Pacinian corpuscles are most numerous in this layer and in the muscle bundles.

**Illustrations**



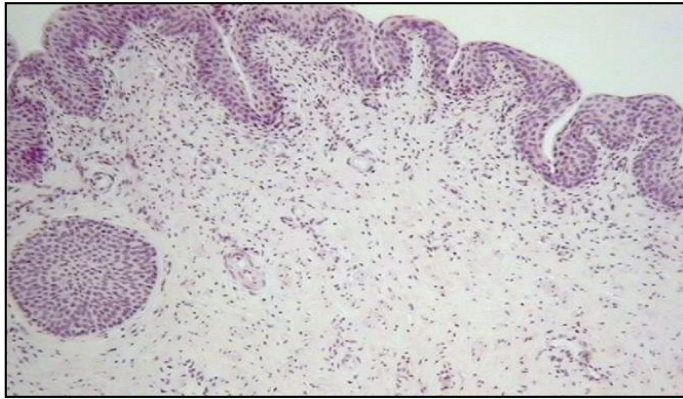
Kidney



Bowman's capsule & glomerulus



Urinary bladder



Female Urethra

**Guide Questions**

1. How would you distinguish a proximal convoluted tubule from that of distal convoluted tubule? Under EM, what features are unique to each type?

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2. What is juxtaglomerular apparatus? Name the cells which constitute this structure and the roles they play in hemodynamics.

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3. How does a male urethra differ from that of female urethra?

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