Chapter 6

Urogenital system

Introduction

The urinary system consists of the kidneys, ureters, urinary bladder, and urethra. The kidneys constitute the glandular component; the remainder of the urinary system forms the excretory passages. The ureters conduct urine from the kidneys to the bladder, where it is stored temporarily. In turn, the bladder is drained by the urethra, through which the urine ultimately is voided from the body.

Among the functions of the kidneys, we have

- Balance the fluids of the internal environment
- Act as a purification station
- Relentlessly filter the plasma
- Excrete in the urine toxins from the liver, metabolic waste like urea, and excess ions
- Recover essential components that have been filtered in order to return them to the blood
- Also play an endocrine role:
    - Secretion of erythropoietin (EPO), which stimulates red blood cell production by the bone marrow
    - Activation of vitamin D, which is involved in growth
    - Secretion of renin, which plays a role in blood pressure regulation

6.1.Kidneys

A retroperitoneal organ, the right kidney is located behind the liver, and the left kidney is located behind the lower pole of the spleen and the tail of the pancreas. The kidney measures 12 cm in height and 6 cm in width. It has a bean-like shape. The adrenal gland rests on the upper pole of the kidney.

Each kidney is composed of:

- an outer renal cortex,
- an inner renal medulla,
- and a renal pelvis.

Blood is filtered in the renal cortex. The renal medulla contains the Malpighian pyramids, where urine is formed. Urine passes from the Malpighian pyramids to the renal pelvis. This funnel-shaped structure occupies the central cavity of each kidney; it gradually narrows as it stretches down to join the ureter.Urine flows from the renal pelvis into the ureter.Each renal lobule is made up of numerous epithelial tubules called **uriniferous tubules** that collectively form the parenchyma of the kidney. Each uriniferous tubule can be divided into a **nephron**, and a **collecting duct**.

6.1.1Nephrons

The human kidney contains 1-2 million nephrons, which are the kidney's functional units. its nephron consists of a renal corpuscle, and the loop of Henle. This later is composed of proximal tubule, a thin segment, and a distal tubule. The renal corpuscle and the proximal and distal convoluted tubules occur only in the cortex, whereas

Henle's loop generally is confined to the medulla or to a medullary ray.

6.1.2. Renal corpuscule

The renal corpuscle consists of **glomerulus (1)** and the **glomerular capsule (2)** with a **parietal layer (2a)** and a **visceral layer (2b).** Between these layers is the **capsular space (5),** with **podocytes (4, 7)** located on the surface of the visceral layer (2b). At the vascular pole of the renal corpuscle, blood vessels enter and leave the renal corpuscle. Adjacent to the vascular pole is the **juxtaglomerular apparatus (3).** The juxtaglomerular apparatus (3) consists of modified smooth muscle cells of the afferent arteriole in the vascular pole, the **juxtaglomerular cells (3a),** and the **macula densa (3b)** of the **distal convoluted tubule (6, 9).** Surrounding the renal corpuscle are the darker-staining **proximal convoluted tubules (8)** and the distal convoluted tubules (6, 9).

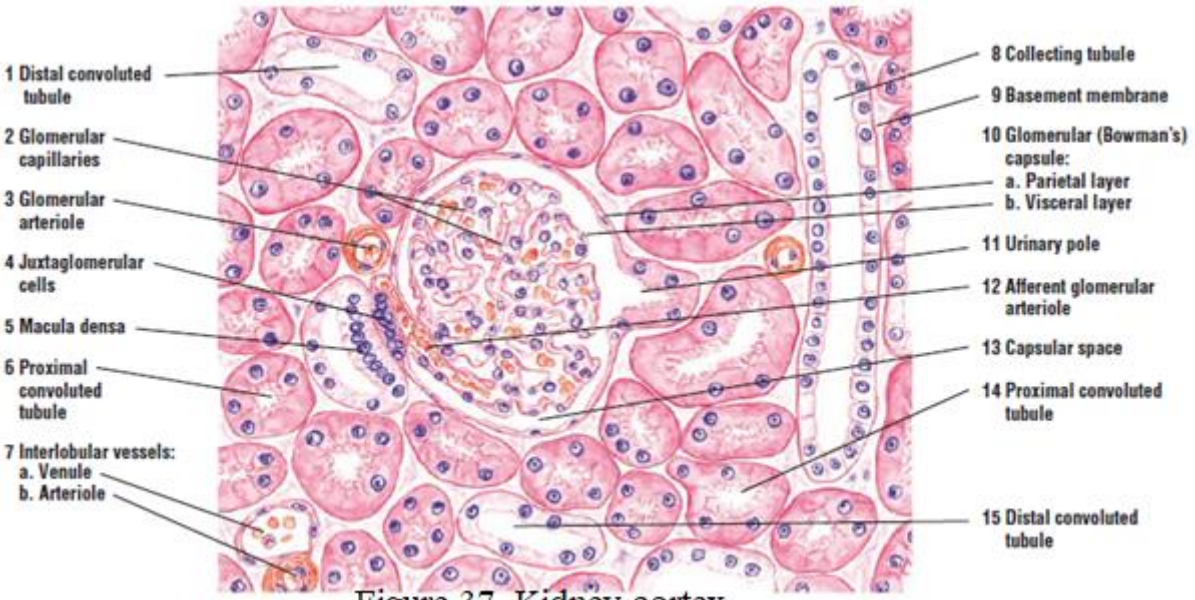

Figure.37. Kidney cortex

6.1.3. Collecting ducts

Thin segments of the loops of Henle (3, 5) descend deep into the papilla and are identifiable as thin ducts with empty lumina. **Venules (1)** and the **capillaries (4)** of the vasa recta are usually identified by the presence of blood cells in their lumina. Surrounding the blood vessels (1, 4) and the papillary ducts (6) is the **renal interstitium (connective tissue) (2).**

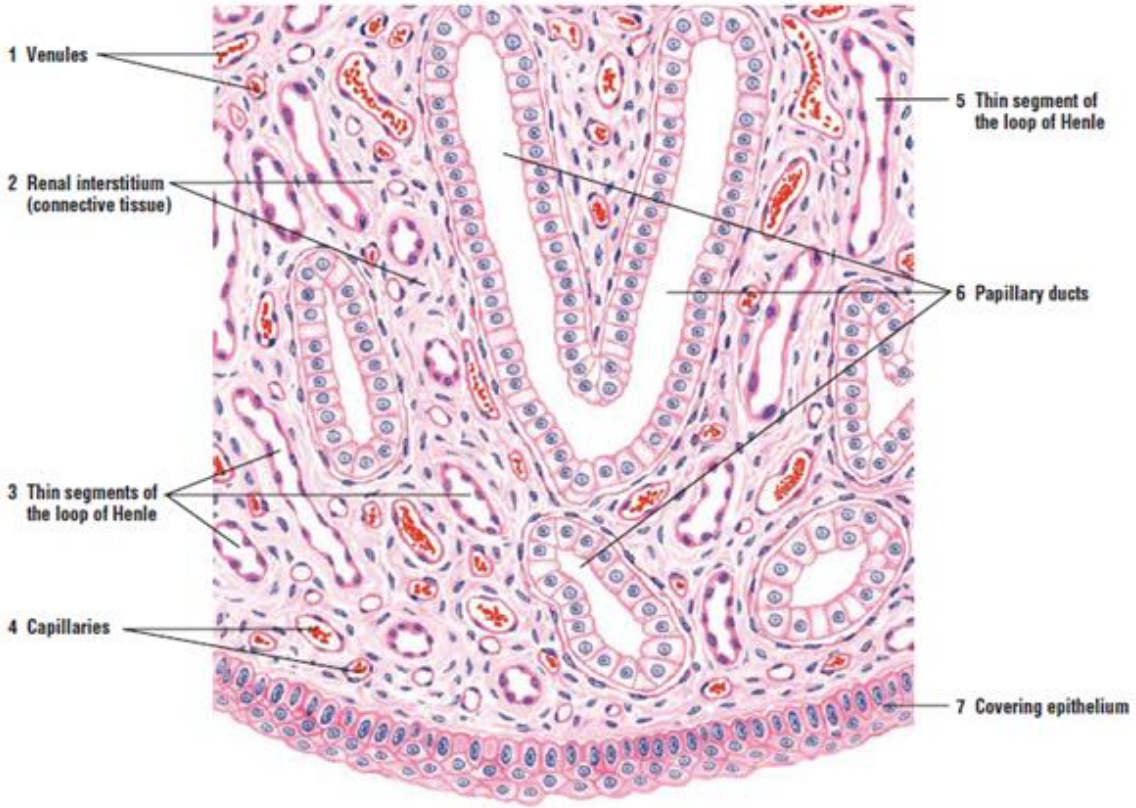

Figure.38. Kidney medulla

The medullary region of the kidney consists primarily of various sized tubules, larger ducts, and blood vessels of the vasa recta. In this photomicrograph, different kidney tubules and blood vessels have been sectioned in a longitudinal plane. The tubules with large, light-staining cuboidal cells are the **collecting tubules (1).** Adjacent to the collecting tubules (1) are tubules with darkerstaining cuboidal cells. These are the **thick segments of the loop of Henle (2).** Between the tubules are blood vessels of the **vasa recta (4)** and the **thin segments of the loop of Henle (3).** Blood vessels of the vasa recta (4) can be distinguished from the thin segments of the loop of Henle (3) by the presence of blood cells in their lumina.

6.2. Ureter

6.2.1. The male urethra

The male urethra is 18-20 cm long and serves dual functions: conveying urine from the bladder and allowing seminal fluid passage during ejaculation. It has three distinct segments:

1. **Prostatic urethra** (3-4 cm): Located within the prostate gland and lined with transitional epithelium like the bladder.
2. **Membranous urethra** (1.5 cm): The shortest segment extending from the prostate to the penis root. It passes through the urogenital diaphragm where skeletal muscle forms the external urethral sphincter, providing voluntary control during urination.
3. **Penile urethra** (15 cm): The longest segment running through the corpus cavernosum to the tip of the glans penis.

The membranous and penile portions are lined with stratified or pseudostratified columnar epithelium, with patches of stratified squamous epithelium in the penile section. The urethral mucosa contains small depressions (lacunae of Morgagni) connected to mucus-secreting glands of Littré. The underlying tissue consists of vascular connective tissue rich in elastic fibers, surrounded by smooth muscle layers.

6.2.2. The female urethra

The female urethra is much shorter than the male urethra (3-5 cm long) and is primarily lined with stratified squamous epithelium, though some areas may have stratified or pseudostratified columnar epithelium. Like the male urethra, it contains Littré glands along its entire length. The underlying lamina propria consists of vascular, fibroelastic connective tissue with numerous venous sinuses. The muscular layer has an inner longitudinal smooth muscle layer and an outer circular layer. The female urethra is also surrounded by skeletal muscle from the urogenital diaphragm, which forms the external urethral sphincter near the urethral opening.

In transverse section, the wall of the ureter consists of mucosa,muscularis, and adventitia.The ureter mucosa consists of **transitional epithelium (7)** and a wide **lamina propria (5).** The transitional epithelium has several cell layers, the outermost layer characterized by large cuboidal cells. The intermediate cells are polyhedral in shape, whereas the basal cells are low columnar or cuboidal.

The lamina propria (5) contains fibroelastic connective tissue, which is denser with more fibroblasts under the epithelium and looser near the muscularis. Diffuse lymphatic tissue and occasional small lymphatic nodules may be observed in the lamina propria. In the upper ureter, the muscularis consists of two muscle layers, an inner **longitudinal smooth muscle layer (3)** and a middle **circular smooth muscle layer (2);** these layers are not always distinct. An additional third outer longitudinal layer of smooth muscle is found in the lower third of the ureter near the bladder.

The **adventitia (9)** blends with the surrounding fibroelastic connective tissue and **adipose tissue (1, 10),** which contain numerous **arterioles (6), venules (8),** and small nerves.

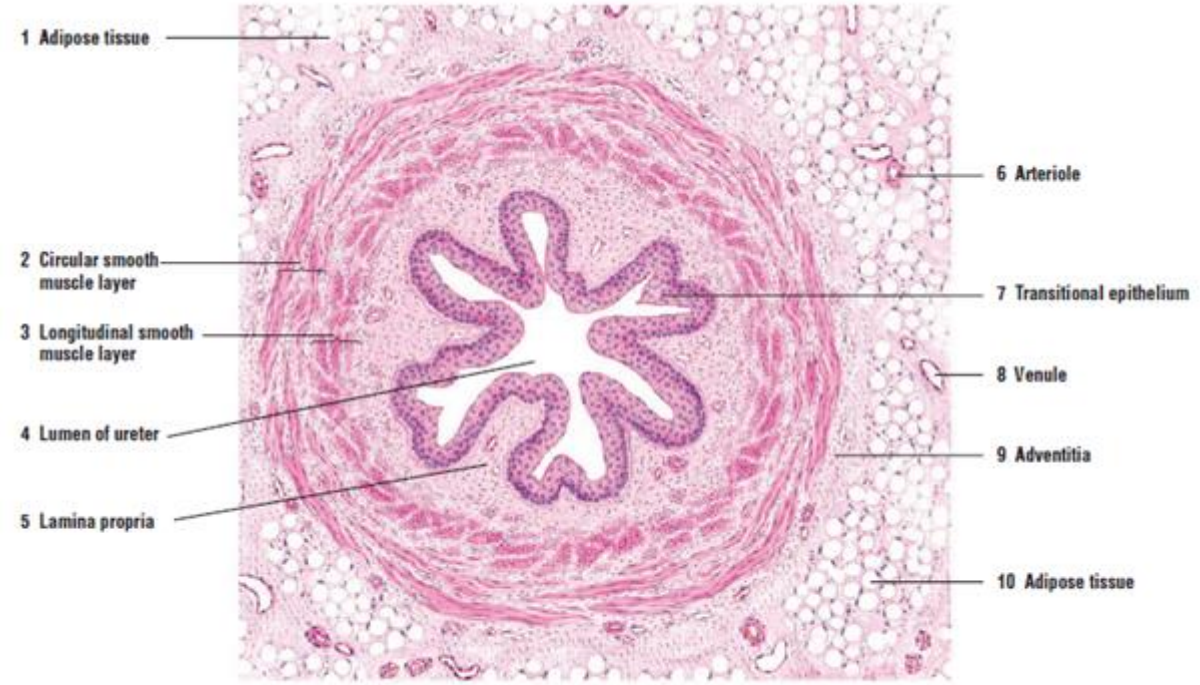

Figure.39. Ureter

6.3. The urinary bladder

The **urinary bladder** is a hollow, muscular organ with a wall composed of four distinct histological layers:

1. Mucosa (Inner Layer):

- **Epithelium**: Transitional epithelium (urothelium) that can stretch and change from stratified cuboidal when empty to flattened when distended
- **Lamina propria**: Loose connective tissue containing blood vessels, lymphatics, and nerves

2. Submucosa:

- Dense connective tissue layer with larger blood vessels and nerve plexuses
- May contain scattered smooth muscle fibers

3. Muscularis (Detrusor Muscle):

- Thick layer of smooth muscle arranged in three loosely organized layers:
  - Inner longitudinal
  - Middle circular
  - Outer longitudinal
- Muscle bundles interwoven rather than distinctly separate
- Contracts as a unit during micturition

4. Serosa/Adventitia (Outer Layer):

- **Serosa**: Visceral peritoneum covering the superior surface
- **Adventitia**: Loose connective tissue on surfaces not covered by peritoneum

The transitional epithelium is the bladder's most characteristic histological feature, allowing accommodation of volume changes while maintaining an impermeable barrier to urine.