Chapter 9 - Urinary system

The objectives of this chapter are:

1. Describe the kidney.
2. State the differences between the two kidneys.
3. Describe the blood supply of the kidney.
4. Name the components of the urinary tract.

1 - Elements of the urinary system

The urinary system is a set of structures that are involved in the filtration of the blood and excretion of the urine, and it consists of:

- paired kidneys which perform the functions of filtration, secretion, and reabsorption.
- paired ureters which transfer the urine from kidneys to the urinary bladder.
- urinary bladder which stores the urine before disposal.
- urethra which transfers the urine from the urinary bladder out of the body.

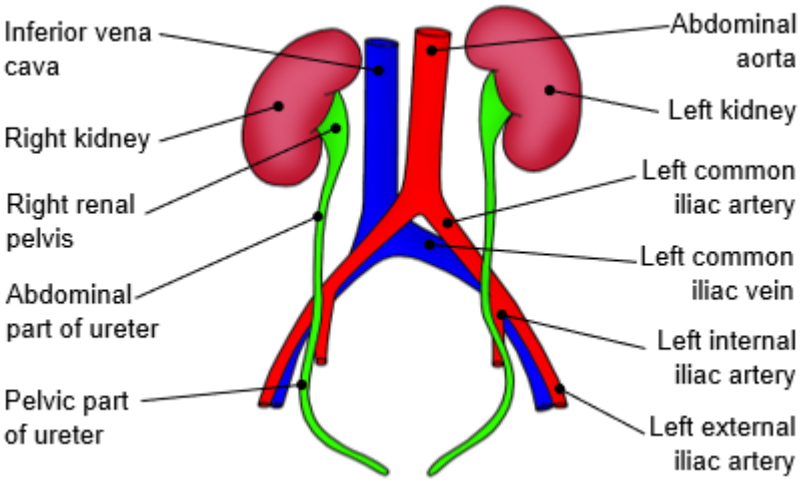

Figure 281: The urinary system showing the kidneys and ureters. Anterior view.

Figure 282: CT reconstruction of the urinary system. Anterior view.

1.1 - Kidney

The left and right kidneys are parenchymatous organs which filter the blood and form the urine. They lie on the posterior abdominal wall, in the retroperitoneal space behind the parietal peritoneum, between the vertebrae T12-L3. The right kidney lies somewhat lower than the left, because of the liver occupying the space.

Morphology of the kidneys

The kidneys are bean-shaped, reddish-brown in colour, of firm consistency. They are approximately 12 cm long, 6 cm wide and 3 cm thick, and they weigh about 120-180 g. They are enveloped in a firm fibrous capsule. Their surface is smooth and regular.

Anterior surface of the kidney is oriented anteromedially and adjacent to some of the other organs of the abdominal cavity. Posterior surface of the kidney is oriented posterolaterally and is adjacent to the muscles of the abdominal wall.

The lateral margin is convex. The medial margin is concave in its centre lies the hilum of kidney.

The superior pole is in contact with the diaphragm. The suprarenal gland is situated above it. The inferior pole is pointed more laterally than the superior one.

Structure of the kidney

The kidney has a lighter brown outer cortex and a dark brown medulla. The hollowed central part of the kidney is called the renal sinus.

The cortex extends towards the renal sinus as renal columns and divides the medulla into 10-15 renal pyramids. The base of pyramids is oriented towards the surface, while the apex called renal papilla projects towards the renal sinus. The urine flows from each renal papilla into the hollow minor calyx which surrounds the papilla. Two or more minor calices join into the major calyx, and major calices join into

the renal pelvis. The pelvis exits the kidney through the hilum and narrows into the ureter.

Blood supply of the kidney

Blood is supplied to the kidney by the renal artery which is a direct branch of the abdominal aorta. The oxygenated blood delivered by renal artery serves the functional and nutritive purposes. The renal artery divides into the anterior branch and posterior branch. Each of them further divides into the segmental arteries.

Altogether, there are 5 segmental arteries supplying the five renal segments. The renal artery also gives off the inferior suprarenal artery and ureteric branches.

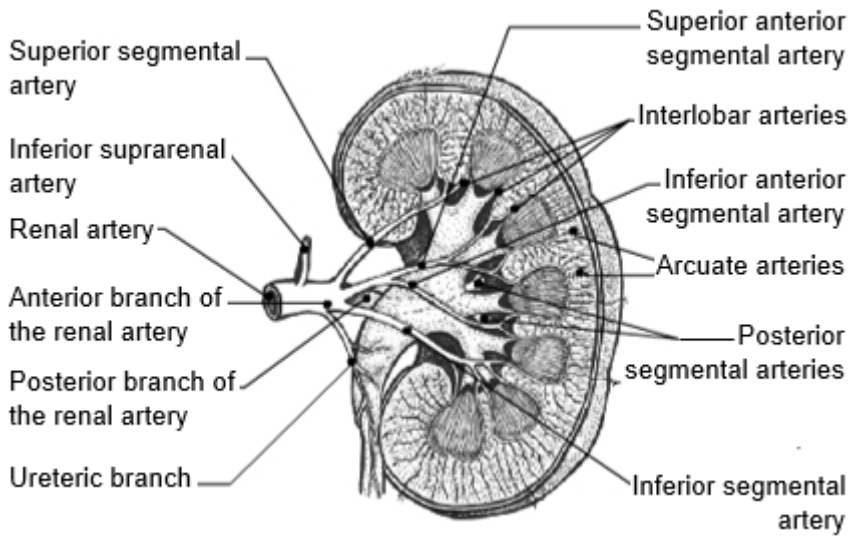

Figure 283: Blood supply of the kidney.

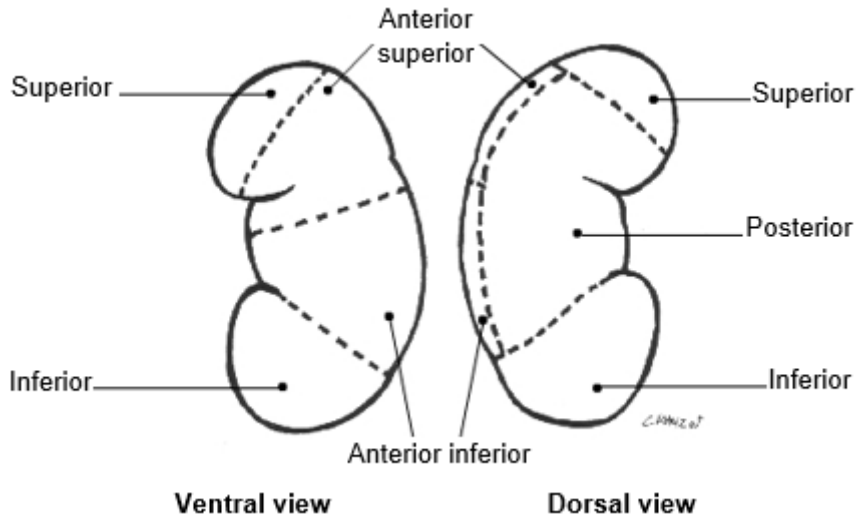

Figure 284: Vascular segmentation of the kidney.

Renal veins drain the filtered blood into the inferior vena cava. Renal veins lie anteriorly to the renal arteries. The left renal vein runs posteriorly to the superior mesenteric artery and can get trapped between this artery and the abdominal aorta.

The renal vessels also serve to fix the kidneys.

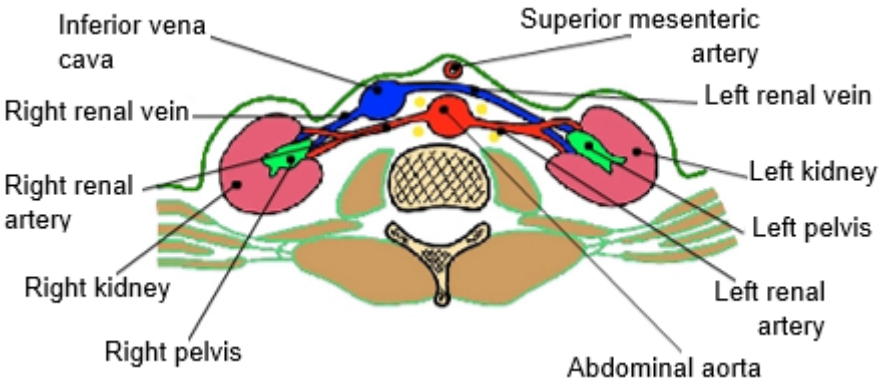

Figure 285: Transverse section through the retroperitoneal space showing renal vessels.

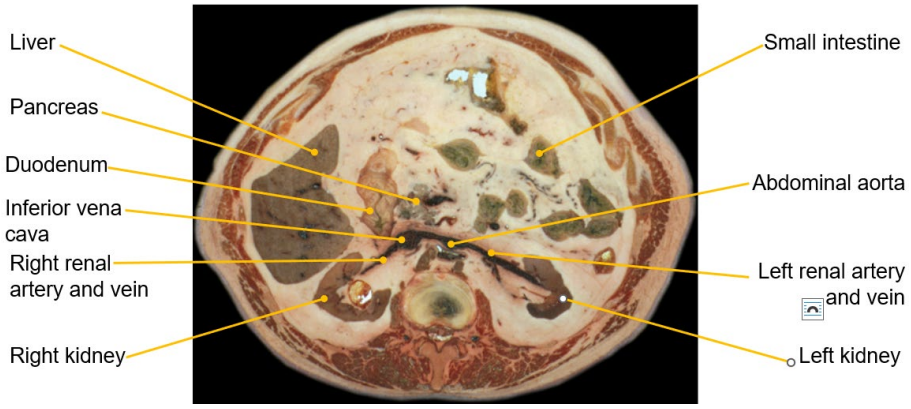

Figure 286: Transverse section through the abdomen showing renal vessels.

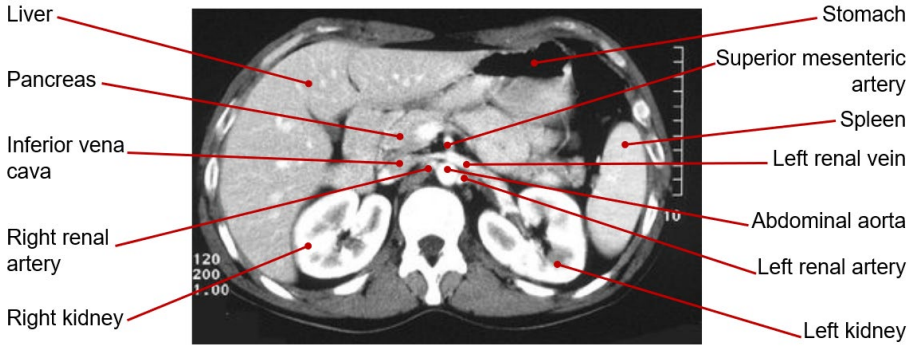

Figure 287: Transverse CT section of the abdomen showing the renal vessels.

1.2 - Ureter

The ureter is a paired muscular tube that extends from the renal pelvis to the posterior surface of the urinary bladder. It is 20-30 cm long and has a diameter of approximately 3-5 mm. It is lined with the urothelium – the transitional epithelium.

The ureter has three parts:

- The abdominal part runs from the renal pelvis downwards behind the parietal peritoneum, along the psoas muscle which separates it from the transverse processes of the lumbar vertebrae. It ends at the pelvic brim.

- The pelvic part enters the pelvis at the bifurcation of the common iliac vessels and then runs in the subperitoneal space down the lateral pelvic sidewall, anteriorly to the internal iliac artery. It finally turns forward and medially to reach the urinary bladder.
- The intramural part lies within the bladder wall and finally opens into the bladder at the ureteral orifice.

The ureter has three physiological constrictions along its course:

- at the junction of the renal pelvis and the ureter,
- at crossing the pelvis brim over the common iliac artery bifurcation, and
- at the junction of the ureter and the bladder wall.

1.3 - Urinary bladder

The urinary bladder is a muscular-membranous reservoir that stores the urine which flows continuously through the ureters. During micturition, it contracts and empties the collected urine through the urethra.

The bladder is very extendable. When empty, it is flattened, but can expand considerably when filled; its capacity is approximately 500 ml (up to 750 ml in male).

The bladder is located in the pelvic cavity, below the parietal peritoneum, close to the pelvic floor, just behind the pubic symphysis. The upper surface of the urinary bladder is covered with parietal peritoneum. In the adult, the empty bladder lies entirely within the pelvic cavity; when it fills, its upper wall rises above the pubic symphysis into the hypogastric region, in the preperitoneal space.

Structure of the urinary bladder

The empty bladder is pyramidal in shape. Its main part is called the body of the bladder. The apex of the bladder is the anterosuperior part of the organ, oriented towards the upper part of the pubic symphysis. From the apex to the umbilicus runs the median umbilical ligament, which is a vestige of the embryological urachus. The fundus of the bladder is the posteroinferior part of the organ. It has a triangular shape. The ureters enter the fundus at the two upper angles of the triangle, and the urethra exits the bladder at the lower angle of the triangle. The neck of the bladder is the inferior part of the organ and is continuous with the urethra inferiorly.

A strong smooth muscle forming the wall of the bladder is called detrusor vesicae.

The inner layer of the bladder wall is the mucous membrane with transitional epithelium which stretches when needed. Thick mucosal folds are present in the empty bladder which disappear when the bladder is full. The mucosa of triangular area in the fundus is called the trigone of the bladder and is always smooth, even when the bladder is empty.

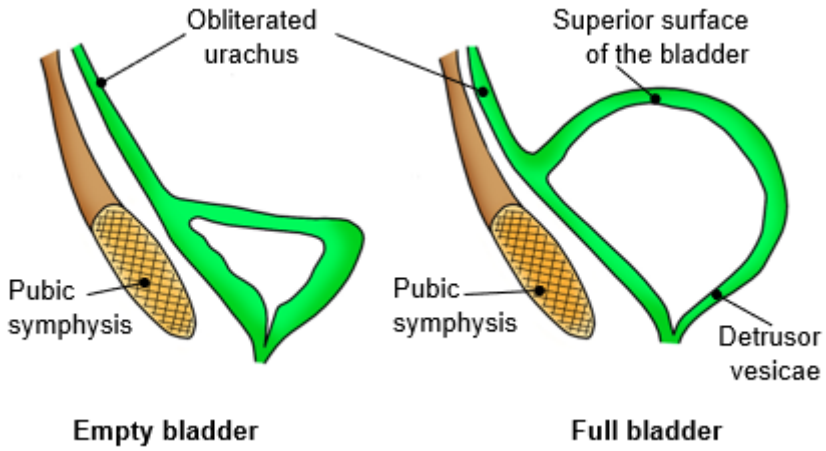

Figure 288: Median section of the urinary bladder.

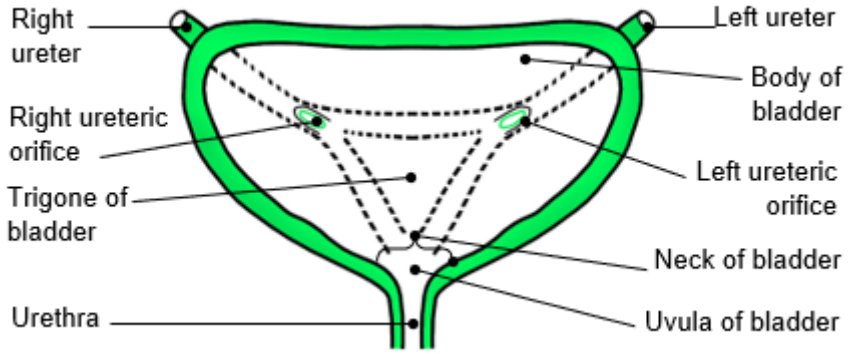

Figure 289: Frontal section of the bladder showing the bladder trigone. Anterior view.

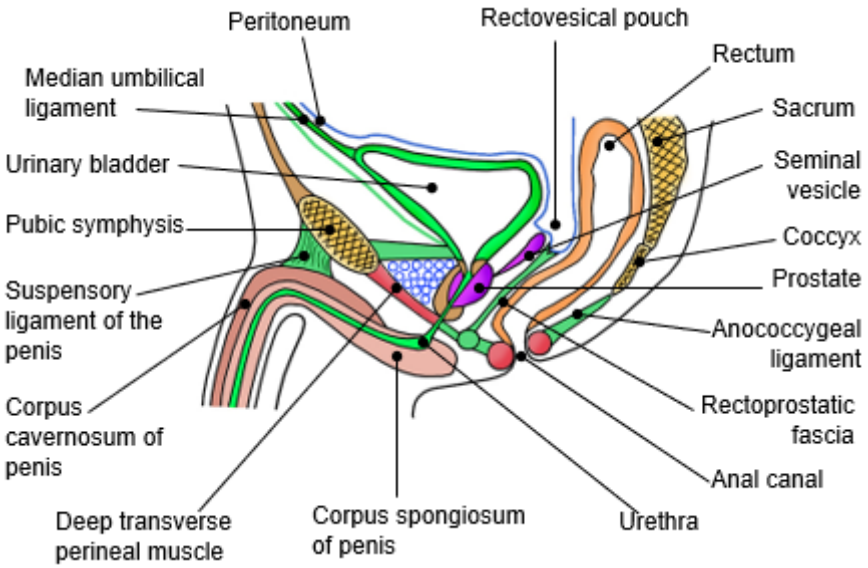

Figure 290: Median section of the male pelvis.

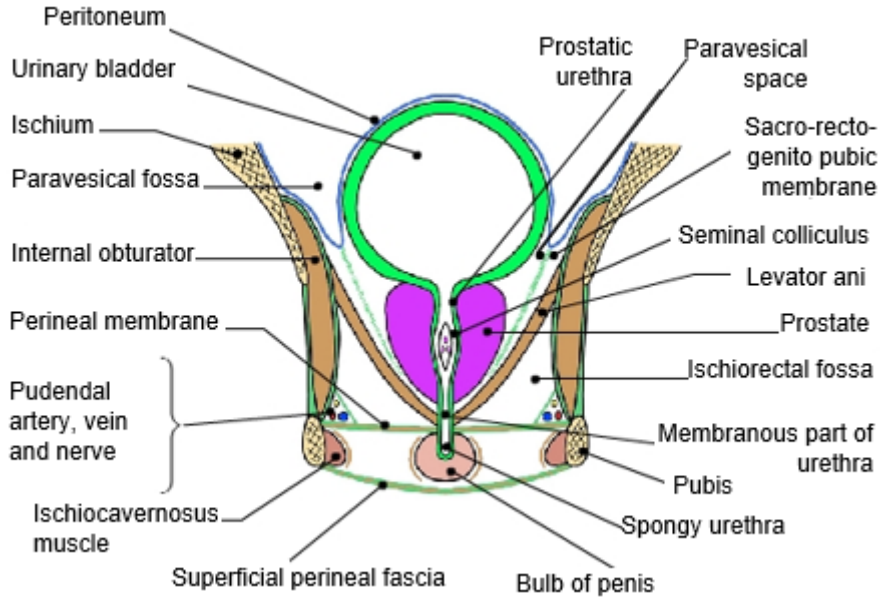

Figure 291: Frontal section of the male pelvis. Anterior view.

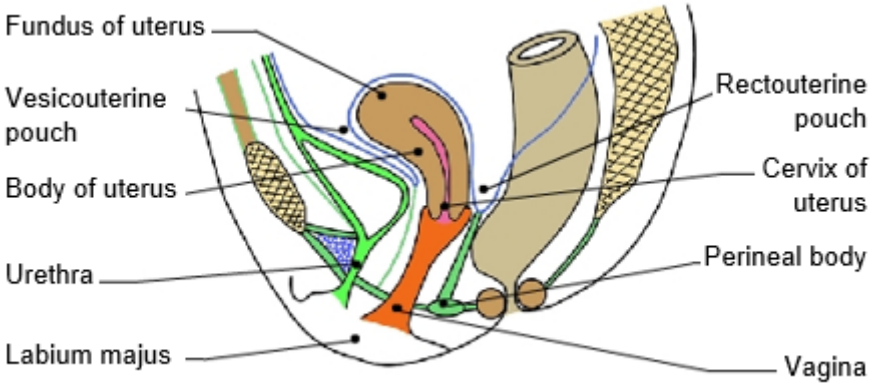

Figure 292: Median section of the female pelvis.

1.4 - Urethra

The urethra is a tube that transports the urine from the urinary bladder to the exterior of the body.

Female urethra

The female urethra is about 4 cm long and runs from the internal urethral orifice in the urinary bladder to the external urethral orifice which lies posteriorly to the clitoris and anteriorly to the vaginal orifice.

It is divided into two parts:

- **Intramural part of female urethra** is about 1 cm long and passes through the neck of the bladder. It is surrounded by the internal urethral sphincter.
- **Membranous part of female urethra** passes through the pelvic floor. It is surrounded by the external urethral sphincter.

The shortness of the female urethra and the closeness of its external orifice to the anus are reasons for frequent urinary tract infections.

Male urethra

The male urethra is about 20 cm long and runs from the internal urethral orifice in the urinary bladder to the external urethral orifice on the glans penis. The external orifice is the narrowest part of the male urethra.

The male urethra does not only transport the urine but also functions as an exit for seminal fluid during ejaculation.

It is divided into four parts:

- **Intramural part of male urethra** is about 1 cm long and passes through the neck of the bladder. It is surrounded by the internal urethral sphincter.

- **Prostatic urethra** is about 3 cm long and passes through the prostate. It is the widest part of the urethra.
- **Membranous part of male urethra** is about 1.5 cm long and lies within the urogenital diaphragm, surrounded by the external urethral sphincter.
- **Spongy urethra** is about 15 cm long and is surrounded by the erectile tissue of the corpus spongiosum of penis.