

# Urological Anatomy and Physiology

## Upper urinary tract (Kidney & Ureter)

### Anatomy:

#### ◆ Kidney:

lie retroperitoneally<sup>1</sup> on the posterior abdominal wall. Each is approximately 3 vertebrae in length, they typically extend from T12 to L3, the right kidney is lower due to the presence of the liver.

#### Anteriorly:

- **Right kidney:** liver, the second part of the duodenum and the ascending colon.
- **Left kidney:** spleen, stomach, tail of pancreas, left colon and small bowel.

**Posteriorly:** 12th rib, costodiaphragmatic pleural recess, psoas, quadratus lumborum and transversus abdominis muscles from medial to lateral.

**Medially:** the renal hilum (transmits from front to back the renal vein, renal artery and renal pelvis).

#### ◆ Ureter:

begins at the renal pelvis and runs for **25 cm** to the bladder.

**The abdominal ureter:** lies on the medial edge of the psoas muscle<sup>2</sup>, which separates it from the tips of the transverse processes.

It then crosses the bifurcation of the common iliac artery<sup>3</sup>, which separates it from the sacroiliac joint, to enter the pelvis.

**The pelvic ureter:** runs on the lateral pelvic wall to just in front of the ischial spine, when it then turns medially and forward to enter the bladder.

#### In the male:

- crossed by the vas deferens.

#### In the female:

- lies close to the lateral fornix of the vagina
- crossed by the uterine vessels, where it is vulnerable to damage during **hysterectomy**.

The section of ureter that lies within the bladder wall functions as a **flap valve** to prevent reflux.

#### Ureter site of constrictions<sup>4</sup>:

- the ureteropelvic junction
- the pelvic brim or inlet<sup>5</sup>
- the ureteric orifice<sup>6</sup>.

<sup>1</sup> behind the peritoneum.

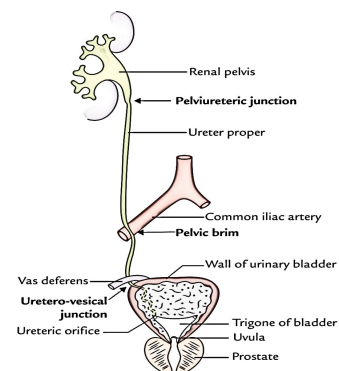
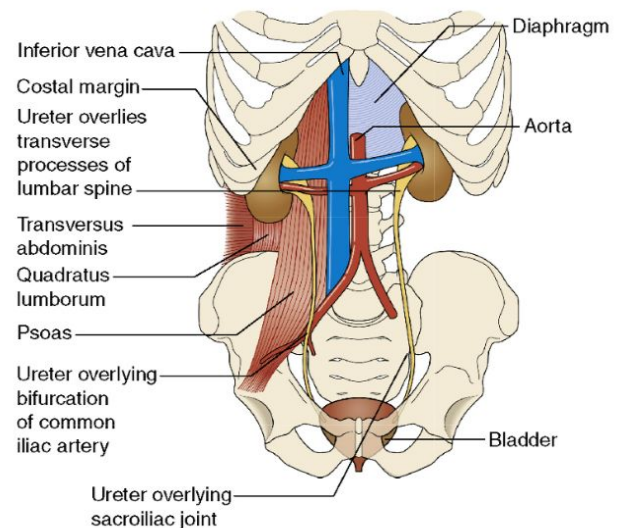
<sup>2</sup> Which helps us in seeing the ureter an plane x-ray

<sup>3</sup> Site at ureteric narrowing

<sup>4</sup> Stones tend to impact and obstruct at these 3 sites

<sup>5</sup> At the site of crossing of the common iliac artery

<sup>6</sup> Site at entrance to bladder



## Physiology:

The healthy kidney can produce between 0.3 and 17 ml of urine per minute<sup>7</sup>, depending on the state of hydration.

Then transported down the ureter by 4 - 5 peristaltic waves per minute to reach the bladder, where it is stored without refluxing up<sup>8</sup> the ureters.

## Lower urinary tract (Bladder, Prostate & Urethra)

### Anatomy:

#### ❖ Bladder:

A muscular reservoir that receives urine via the ureters and expels it via the urethra.

- In children up to 4 years: lies predominantly in the abdomen.
- In adults: it is a pelvic organ, well protected in the bony pelvis.

**Superiorly:** covered with peritoneum, which separates it from coils of small bowel, the sigmoid colon and, in the female, the body of the uterus.

**Posteriorly:**

- In **male:** rectum, vas deferens and seminal vesicles.
- In **female:** rectum, vagina and supravaginal cervix .

**Inferiorly:** the neck of the bladder transmits the urethra and fuses with the prostate in the **male** and with the pelvic fascia in the **female**.

The bladder is composed of whorls of **detrusor** muscle, which:

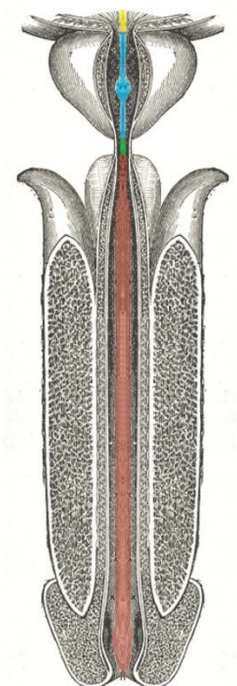
- In **male** become circular at the bladder neck. They are richly supplied with sympathetic nerves that cause contraction during ejaculation, thereby preventing semen from entering the bladder (retrograde ejaculation).
- In **female:** There is no such sphincter.

The bladder is lined with specialized waterproof epithelium, the **urothelium**<sup>9</sup>. This is thrown into folds over most of the bladder, except the trigone where it is smooth.

#### ❖ Urethra:

- In **male:** the urethra is 20 cm long<sup>10</sup>; divided into 3 region:

<b>Prostatic urethra</b>	<b>3 cm</b>
<b>Membranous urethra</b>	<b>1-2 cm</b> long and intimately associated with the main urethral sphincter, the rhabdosphincter
<b>Penile or spongy urethra</b>	<b>15 cm</b> long and surrounded by the corpus spongiosus. opening on the tip of penis as the external meatus.



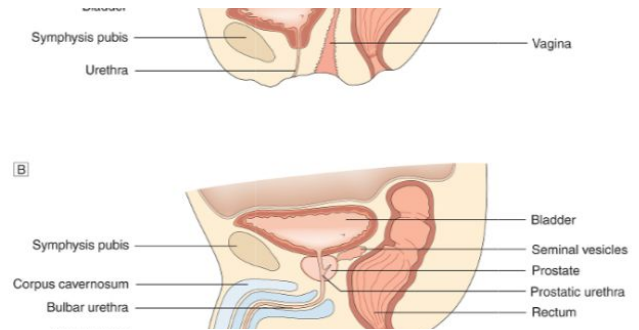
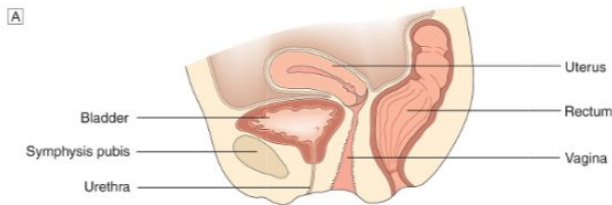
<sup>7</sup> 800 - 2000 ml per day

<sup>8</sup> Due to the ureteric flap valve

<sup>9</sup> an example of "transitional epithelium"

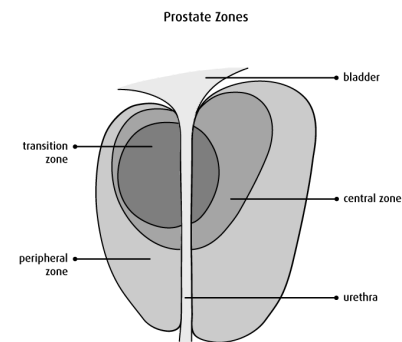
<sup>10</sup> More susceptible to obstructive diseases and urethritis

- In **female**: the urethra is 3-4 cm long<sup>11</sup>, descending through the pelvic floor surrounded by the urethral sphincter and embedded in the anterior vaginal wall to open between the clitoris and the vagina.



### ◆ Prostate:

In the **male**, the prostate is pyramidal, with its base uppermost. It resembles the size and shape of a chestnut and surrounds the prostatic urethra. Traditionally described as having a median and two lateral lobes, it is better considered as being composed of a small central and a larger peripheral zone



## Physiology:

### Neurological control of micturition:

Detrusor contraction is mediated through

- cholinergic **parasympathetic nerves** arising from the nerve roots S2–S4..
- **Sympathetic nerves** arise from T10 to L2 and relay via the pelvic ganglia.

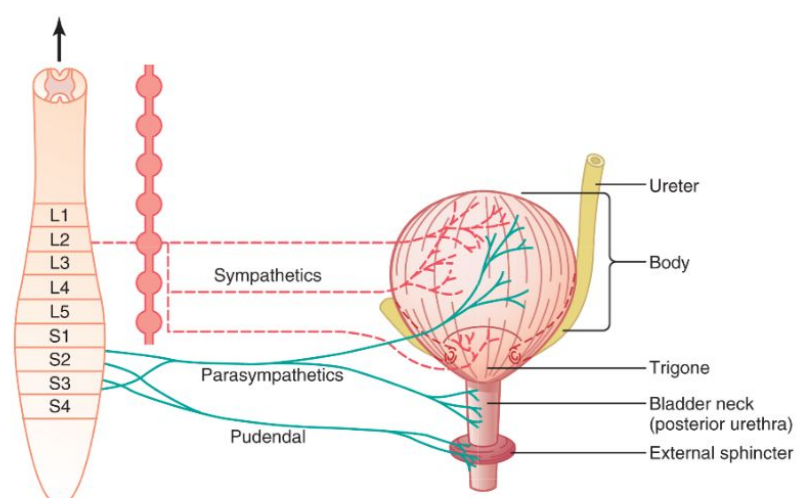
The  $\alpha$ -adrenergic receptors are found mainly in the smooth muscle of the bladder neck and proximal urethra, Which respond to noradrenaline (norepinephrine) by stimulating contraction, thereby maintaining closure of the bladder neck.

The distal sphincter mechanism is innervated by somatic motor fibres from S2–S4 that reach the sphincter either by the **pelvic plexus** or via the **puddental nerves**.

Afferent nerves are carried in both the parasympathetic and pudental pathways and transmit sensory impulses from the bladder, urethra and pelvic floor.

These sensory impulses pass to the cerebral cortex and the micturition centre, where they produce reflex bladder relaxation and increased tone in the distal sphincter, so helping maintain continence.

The higher centres suppress **detrusor** contractions and their main function is to inhibit micturition until an appropriate time.



<sup>11</sup> More susceptible to UTI

❖ **The micturition cycle** has two phases:

### Storage (or filling) phase:

Due to the high compliance (elasticity) of the detrusor muscle, the bladder fills steadily without a rise in intravesical pressure. As urine volume increases, stretch receptors in the bladder wall are stimulated, resulting in reflex bladder relaxation and reflex increased sphincter tone. At three-quarters of bladder capacity, sensation produces a desire to void. Voluntary control is now exerted over the desire to void, which temporarily disappears. Compliance of the detrusor allows further increase in capacity until the next desire to void. Just how often this desire needs to be inhibited depends on many factors, not the least of which is finding a suitable place in which to void.

### Emptying (or micturition) phase:

The act of micturition is initiated first by voluntary and then by reflex relaxation of the pelvic floor and distal sphincter mechanisms, followed by reflex detrusor contraction. These actions are coordinated by the pontine micturition centre. Intravesical pressure remains greater than urethral pressure until the bladder is empty.

## External genitalia

### Anatomy:

In **male**: penis, testicles and scrotum.

#### ❖ **Penis:**

consists of 3 cylinders of erectile tissue:

The ventral corpus spongiosum is expanded proximally as the bulb and distally as the glans penis, and transmits the urethra.

Two dorsolateral corpora cavernosa attach to each side of the inferior pubic arch as the crura. They form the body of the penis and become embedded in the glans.

Blood is supplied from the internal pudendal arteries.

#### ❖ **Scrotum and Testicles:**

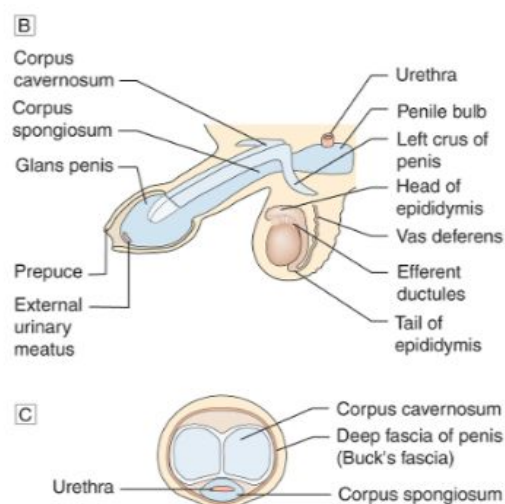
a thin rugose pouch of skin containing the two testicles. Each testicle is contained within a tough capsule (**tunica albuginea**) and has the epididymis attached to it posteriorly.

This highly coiled tubular structure arises from the rete testis, where some 20 small tubules enter it.

This head of epididymis is considerably larger than the lower tail,

from which the vas deferens arises to traverse the spermatic cord and finally to open into the prostatic urethra as the ejaculatory duct.

The testicle and epididymis are invaginated into the tunica vaginalis, which lies anteriorly, so providing a potential space where a hydrocoele may form.





<b>Arterial supply</b>	testicular arteries
<b>Venous drainage</b>	Venous blood drains along the spermatic cord as the pampiniform plexus
<b>Lymphatic drainage</b>	scrotum drains into the inguinal lymph nodes, and the contents of the scrotum drain along the spermatic cord to the pelvis and abdomen nodes.

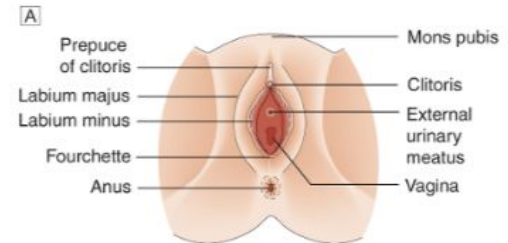
In **female**: mons pubis, labia majora, labia minora and the clitoris.

❖ **mons pubis and labia:**

is the fatty elevation over the pubis from which the labia run backwards, enclosing between them the vestibule into which open the vagina and urethra.

❖ **Clitoris:**

lies above the urethral opening and is a smaller replica of the penis, with the same erectile tissues.



**Physiology:**

**Parasympathetic** stimulation leads to erection through the release of nitric oxide, with resultant vasodilatation of the arterioles, increased penile blood flow and passive closure of the venules.

**Sympathetic** stimulation is responsible for this emission, and also closes the bladder neck to prevent leakage of semen into the bladder. Ejaculation proper is due to rhythmic contraction of the bulbospongiosus muscles expelling the semen out through the urethra.