Anatomy Of The Kidney

• The kidneys are found bilaterally either side of the vertebral column lies at T12–L3, outside the peritoneal cavity.

• Their role is to filter and excrete waste products from blood and urine, as well as to regulate body fluid composition. In addition, the kidneys are important endocrine organs.

• Size approximately: 11cm long - 6cm wide - 4cm deep.

• The right kidney sits slightly lower (about 12mm) than the left kidney, since it is displaced by the right lobe of the liver.

• The kidneys move up and down with respiration.

• The renal hilum (the point at which the renal vessels, ureters, and nerves enter and leave the kidney) is an opening on medial aspect of each kidney. The left renal hilum is at the same level as the transpyloric plane, and the right is usually slightly lower.

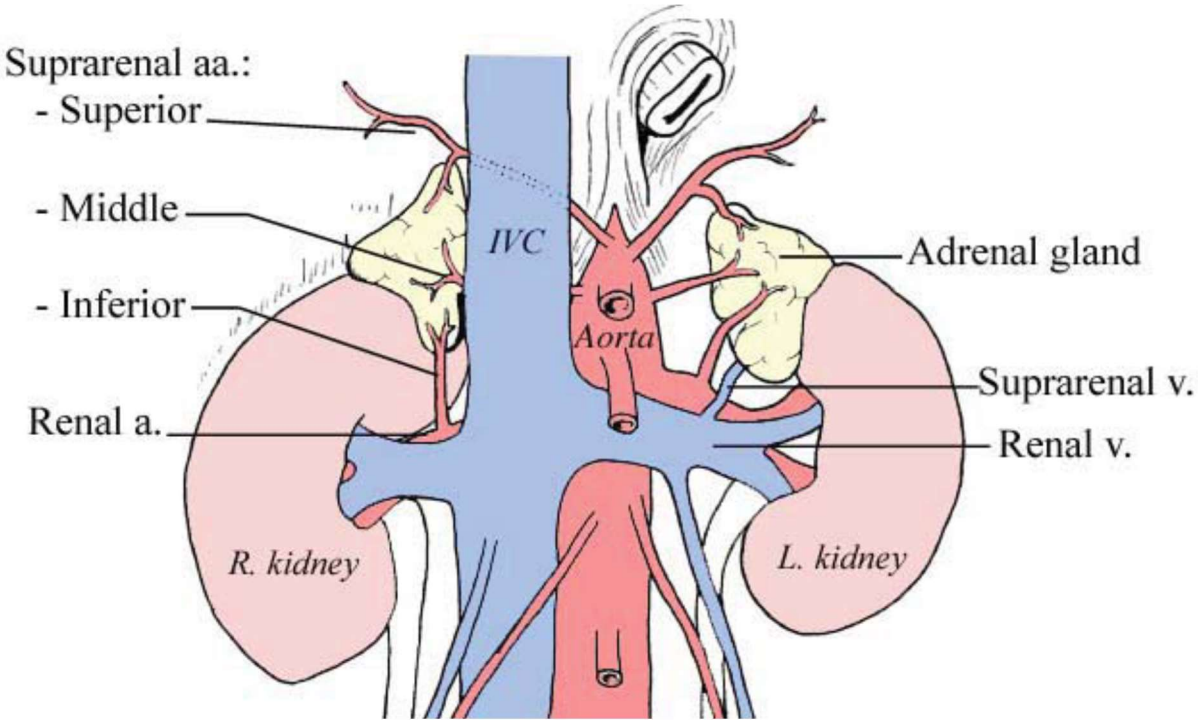
• Moving anteriorly to posteriorly, the hilum usually contains:

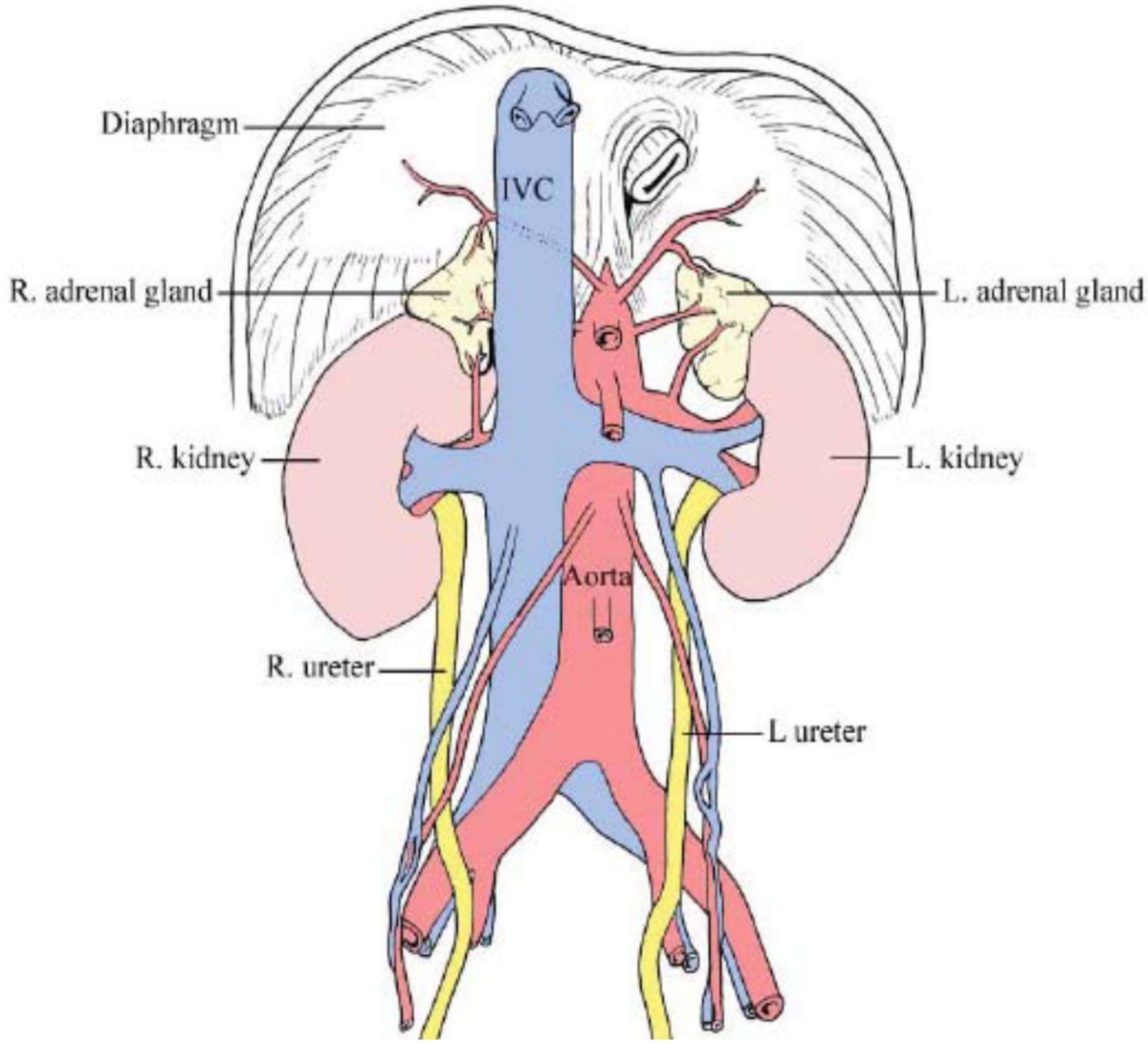
1-Renal vein2-Renal artery

3-Renal pelvis4-Subsidiary renal artery

5-Lymph vessels, nerves, and fat occupy a more variable position within the hilum.

• The renal pelvis drains urine from the two or three major calyces of the kidney, with two or three minor calyces draining into each major calyx. In turn, each minor calyx is fed by renal papillae tissue, and this represents the point at which the collecting ducts of the kidney transmit urine into the ureter. The renal pelvis can be intra or extra renal, depending on whether it is completely enclosed by the kidney.


Suprarenal aa.:
- Superior
- Middle
- Inferior
Renal a.
IVC
Aorta
Adrenal gland
Suprarenal v.
Renal v.
R. kidney
L. kidney



<u>Coverings of kidney: kidneys are surrounded by 4 distinct coverings</u>:

1-<u>The fibrous capsule</u> of the kidney almost completely encloses it and is separated from the renal fascia by a layer of peri-renal fat.

2- <u>Renal fascia</u> is a fibrous tough tissue around the kidney and adrenal glands that projects bundles of collagen into the surrounding fat, helping to anchor the kidney in position.

3 & 4-Together, the <u>peri-renal fat</u> and <u>para-renal fat</u> (which lies outside the layer of renal fascia, particularly posteriorly) form a double protective layer of fat around the kidney.

<u>Gross structure</u>:

• The kidney is made up of an outer cortex and an inner medulla.

• Medulla is lighter brown in color and contains a dozen renal pyramids that are oriented such that point feeds into minor calyces.

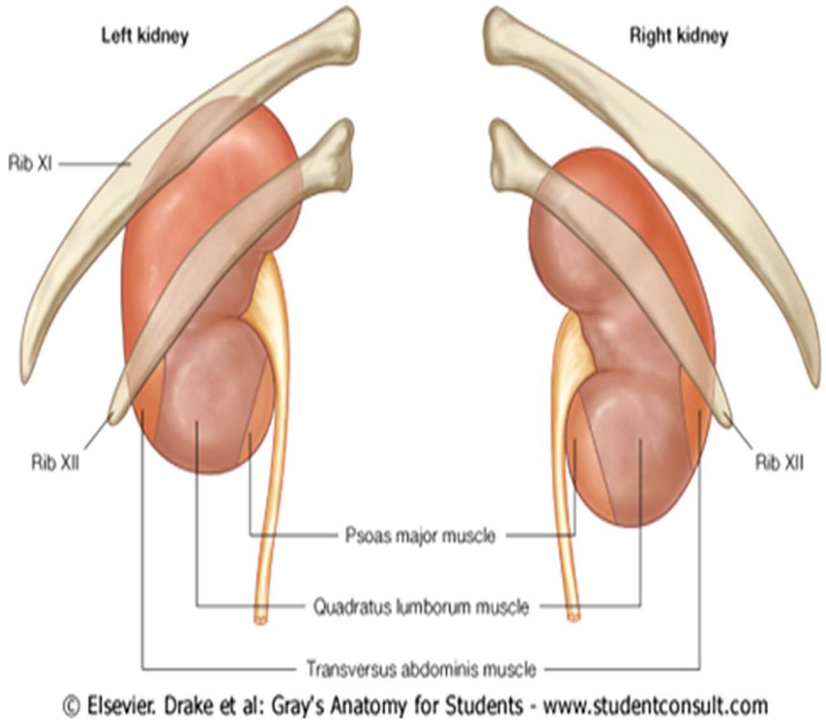
• Cortex comprises all of the outer lateral regions of kidney.

•Medullary rays are striated areas which project from bases of renal pyramids, through renal cortex.

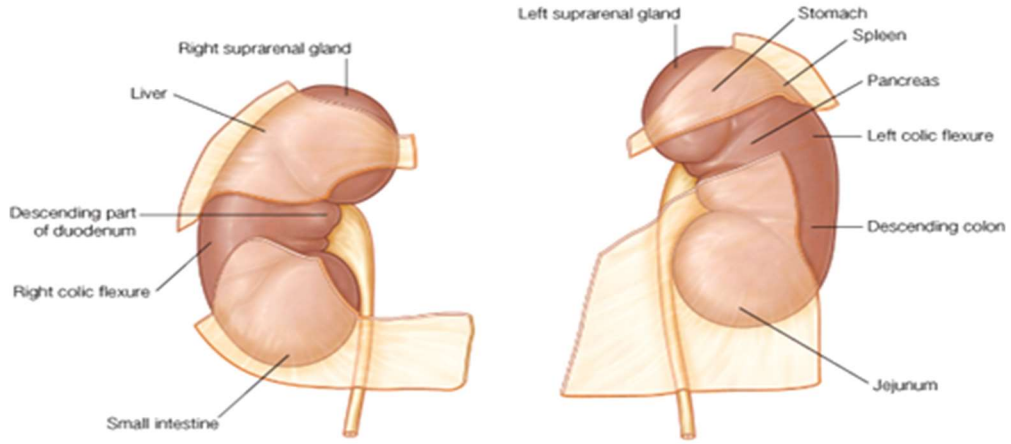
Anatomical relations

Right kidney & Left kidney
Superiorly: Diaphragm separates from (similar)pleura and 11 &12th rib. Adrenal glands cap superior pole of each kidney.
Posteriorly: Quadratuslumborum, (similar) transversusabdominis, psoas Ilio-hypogastric & Ilio-inguinal nerves, subcostal nerve/vessels
Anteriorly: Liver, 2nd part of duodenum, (differs) ascending colon, Spleen, jejunum, pancreas, and blood vessels, stomach, descending colon.

Posterior Relations



Anterior Relations



Blood supply and lymphatic drainage:

• The renal arteries arise from the aorta at L1–2.

• The right artery is longer and runs behind the inferior vena cava to cross to the right side.

• Close to the hilum of each kidney, the artery divides into five segmental end arteries. They supply the segments of the kidney.

• Each segmental artery gives rise to lobar arteries, which each supply an individual renal pyramid. Two or three inter-lobar arteries are given off by each lobar artery. Inter-lobar arteries then enter the renal cortex on either side of the renal pyramid.

• Arcuate arteries are given off by the inter-lobar arteries at the intersection of cortex and medulla over the base of the pyramids.

• These arteries give off several interlobular arteries, which enter the cortex. From these arteries, the afferent glomerular arterioles arise to supply the glomerulus, and ultimately form vasa recta of medulla.

• The venous drainage of the kidney largely parallels the arterial supply, with veins following a similar route to arteries. The renal vein runs anterior to the renal artery as it leaves the hilum. The left vein is longer, having to cross in front of the abdominal aorta.

<u>Lymphatic drainage:</u> is to the para-aortic and lumbar lymph nodes.

<u>Nerve supply:</u> Thoracic splanchnic nerves form a renal plexus containing mainly sympathetic& parasympathetic vasomotor nerves.

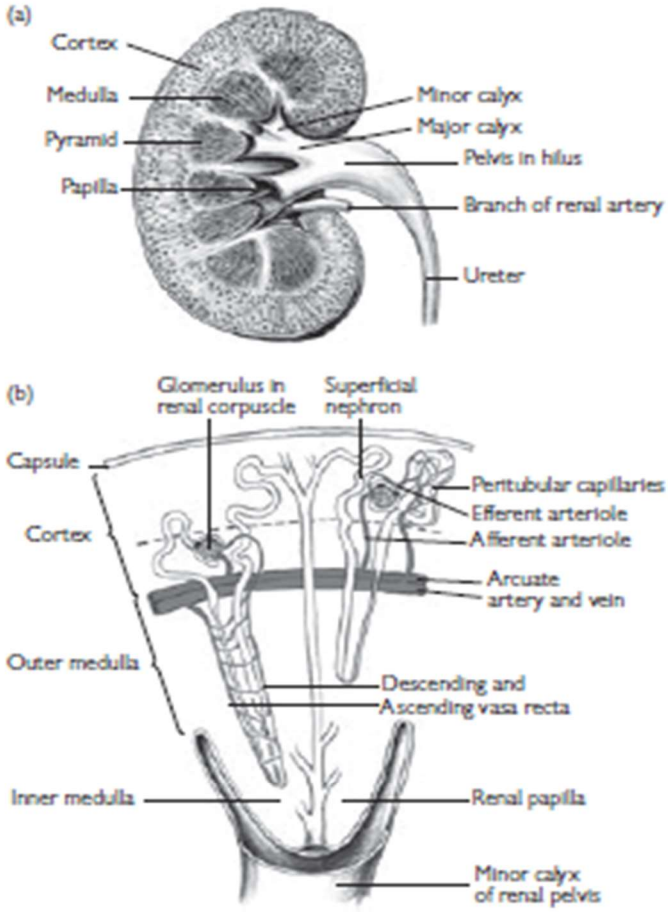


Fig. 7.1 (a) Diagram of hemisected kidney to show its component parts. (b) Arrangement of kidney microvasculature.

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The Ureters

These are muscular tubes lined with transitional epithelium which, by peristalsis,carry urine produced by the kidneys to the bladder for storage andexcretion.

•They are approximately <u>25cm long</u> and are commonly considered <u>in four parts</u>, starting with the <u>renal pelvis</u>, which narrows to form the <u>abdominal</u>

part, then pelvic, and, finally, intra-vesical (bladder wall) sections of the ureter.

Anatomical relations:

The right ureter is covered by 2nd part of the duodenum anteriorly at the renal pelvis, and lies behind the posterior peritoneum, lateral to the inferior vena cava. It is crossed by three vessels:

1-Right colic artery

2-Testicular/ovarian artery

3-Ileocolic artery.

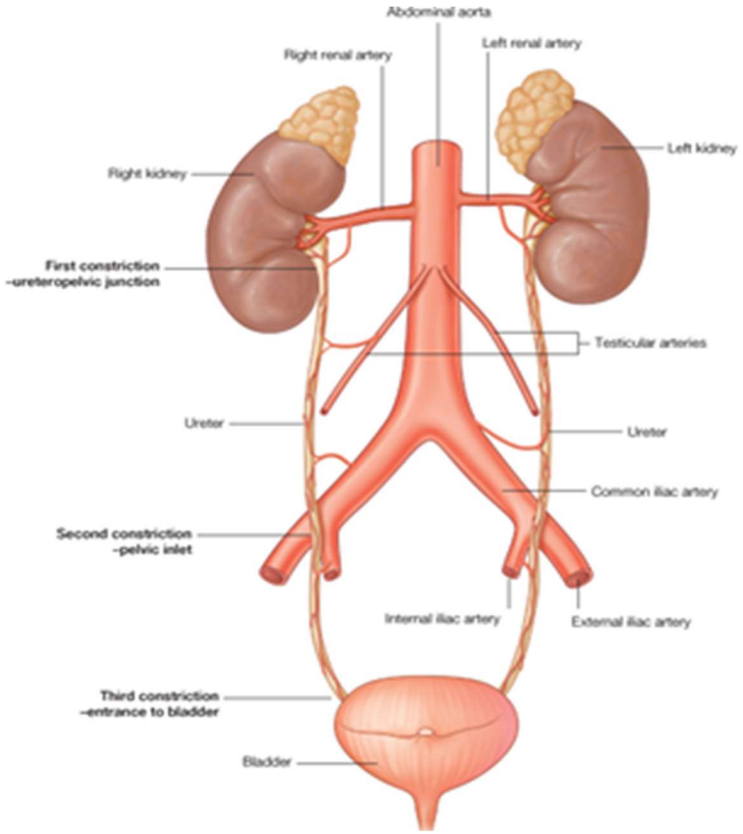
The left ureter passes along medial border of psoas and behind the sigmoid mesocolon and sigmoid colon. It is crossed by two vessels:

1-Left colic artery

2-Testicular/ovarian artery.

Both ureters cross the pelvic brim level with the division of the right and left common iliac arteries into internal and external segments, and these points mark the beginning of the pelvic sections of the right and left ureters.

The final intra-vesical part of the ureters runs obliquely through the wall of the bladder. The oblique course allows the opening of ureters to act like a valve, preventing back flow of urine from bladder.



<u>There are three normal sites of narrowing's</u> of the ureter where kidney stones are most likely to become lodged:
1-The junction of renal pelvis with the abdominal part of the ureter
2-The pelvic brim, where the ureter enters the pelvis
3-The pelvi ureteric junction, where ureter enters the bladder wall.

<u>Blood supply to the ureters</u>
1-<u>Renal pelvis part</u> from Aorta and renal arteries
<u>2-Abdominal part</u> from Aorta, renal, and testicular/ovarian arteries
<u>3-Pelvic part</u> from Testicular/ovarian and internal iliac arteries
<u>4-Intravesicalpart</u> from Internal iliac and inferior vesicle arteries
<u>The ureters are drained by the testicular/ovarian veins</u>.

<u>Lymphatic drainage</u> of the ureters is to the lumbar lymph nodes and to the internal, external, and common iliac lymph nodes.

<u>The Urinary Bladder</u>

The bladder is a balloon-like structure, lined with transitional epithelium. It expands and contracts as it stores and excretes urine, which is produced by the kidneys and drains into it via the ureters. In humans, urine is excreted via the urethra under the voluntary control of the internal meatus. Most adult subjects begin to feel the sensation of a full bladder once it contains approximately 250mL.

Morphology of the bladder:

• The bladder is a relatively mobile organ within the pelvic cavity, surrounded largely by extra-peritoneal fat.

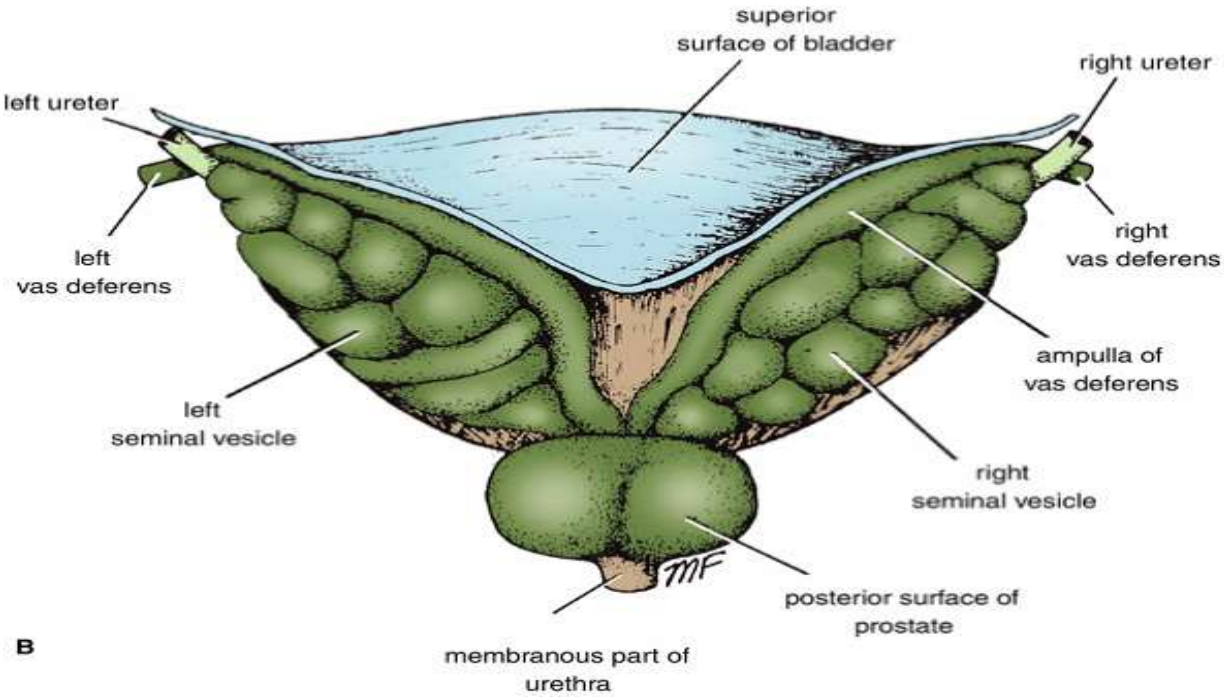
•Shape: empty bladder is pyramidal in shape, with the apex formed by the bladder wall behind the pubic symphysis.

•The apex of the bladder is directed toward the top of the pubic symphysis; a structure known as the median umbilical ligament (a remnant of the embryologic urachus) continues from it superiorly up the anterior abdominal wall to the umbilicus.

•The base(or the posterior surface) is formed by the posteroinferior aspect of the bladder (sometimes called the fundus). The two ureters enter the bladder at each of the upper corners of the base, and the urethra drains inferiorly from the lower corner of the base.

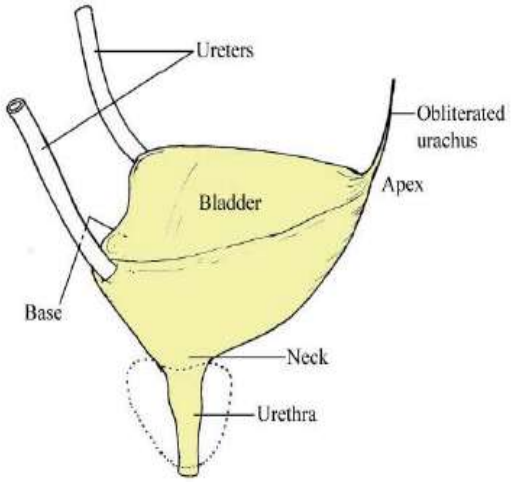
•The neck is the most inferior part of the bladder and also the most 'fixed' part. The bladder is anchored at its neck by the pubovesical ligament (in females) or the puboprostatic ligament (in males).

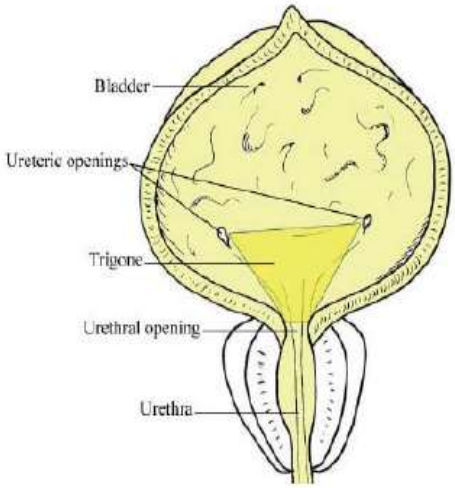
- **In females, the neck sits on pelvic fascia, surrounds short urethra.**
- **In males, bladder neck merges with prostate and urethra is much longer, extending along length of the penile shaft to external meatus.**



<u>Surfaces of bladder are three (one superior and two infero-lateral)</u>:

The superior surface is slightly domed when the bladder is empty; it balloons upward as the bladder fills. The inferolateral surfaces of the bladder are related to of the pelvic diaphragm.





•<u>Peritoneal covering</u>: In adults, the bladder is an extra-peritoneal organ but, as it fills, it expands upwards into the abdomen, stripping peritoneum upwards from the anterior abdominal wall. In children up to 3 years old, the

bladder is an intra-abdominal, extra-peritoneal organ, due to the relatively small pelvis of a child.

•The trigon is an area of the bladder wall which is smooth, even when the bladder is empty, because the mucosa in this area of the bladder is adherent to the underlying smooth muscle. This area is bounded by the internal meatus and the two ureteric orifices, forming the triangular area.

•The internal urethra sphincter (internal meatus) is formed by circular fibres from the smooth muscle of the trigone area.

•The external sphincter is made of striated (skeletal) muscle as part of the urogenital diaphragm muscle.

• In the rest of the bladder, the mucosa is loosely adherent to the underlying detrusor muscle, causing folding or rugae of the mucosa when the bladder is empty. An inter-ureteric ridge runs between the two ureters, formed by a band of muscle underlying the mucosa.

Anatomical relations:

• Anteriorly, the bladder is bounded by the pubic symphysis and, laterally, by the obturator internus and levator ani muscles.

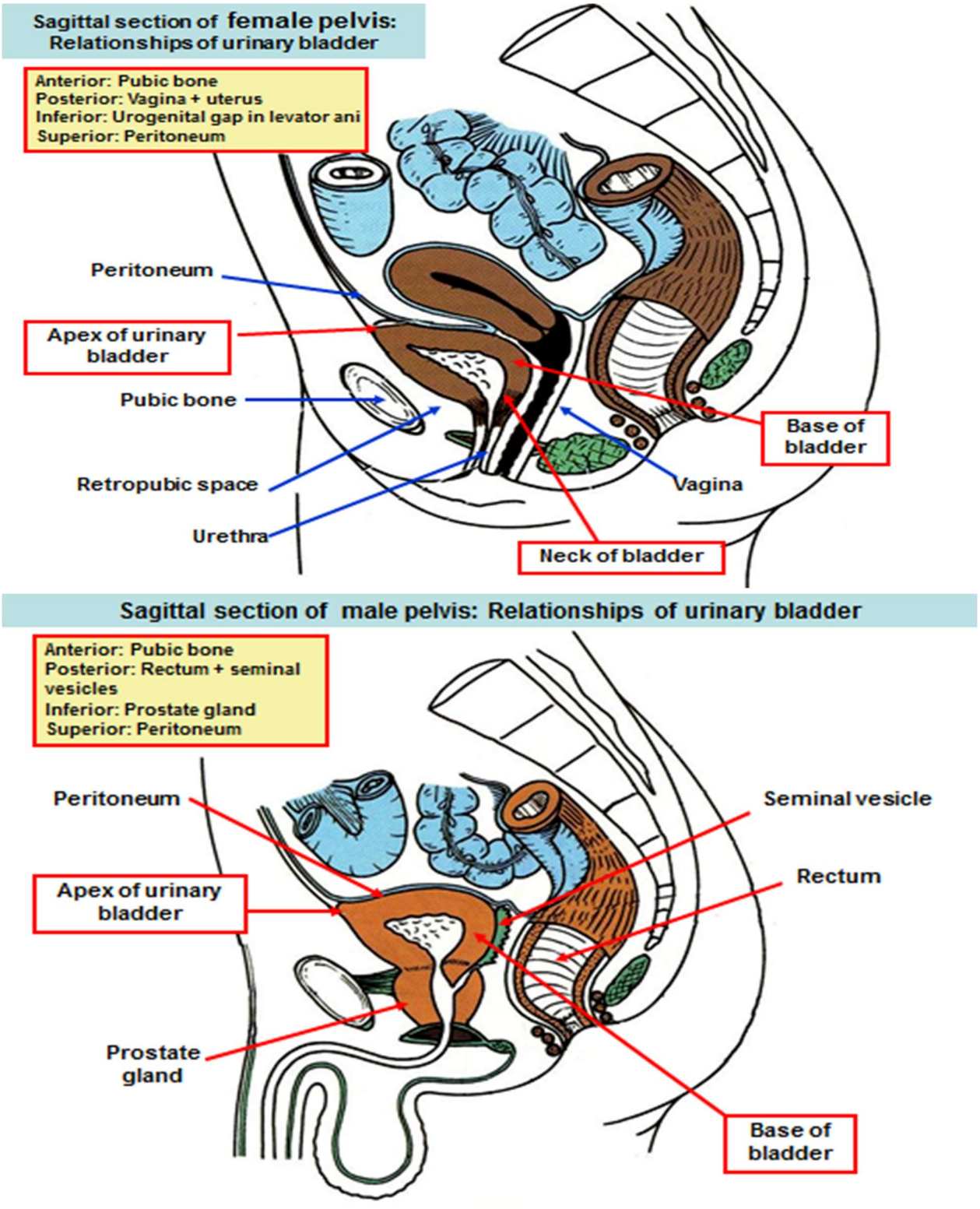
•Posteriorly: differs from male and female:

1-in the male, the bladder is surrounded by the rectum, seminal vesicles, and termination of the vas deferens.

2-In the female, it is bounded, posteriorly, by vagina and superior part of the cervix

• Superiorly, the bladder is covered by the peritoneum. Coils of small intestine and sigmoid colon lie above the layer of the peritoneum.

The uterus of the female can lie against the posterosuperior aspect of the bladder.



Blood supply

- **The internal iliac arteries supply the bladder via the superior and inferior vesicle branches.**
- **The superior vesicle artery supplies the antero-superior part of the bladder.**
- **In males, the fundus of the bladder is supplied by the superior vesicle artery; in females, the fundus is supplied by vaginal arteries**
- **The vesicle venous plexus drains the bladder**
- **In men, this plexus is formed by the vesicle veins and combines with the prostatic venous plexus. The vesicle plexus drains via the internal vesicle veins to the internal iliac veins.**
- **In females, the vesicle venous plexus communicates with the vaginal venous plexus and also receives blood from the dorsal vein of the clitoris. As in males, blood is eventually drained to the internal vesicle and the internal iliac veins.**

Lymphatic drainage

Lymph is drained from the bladder in parallel to the vesicular blood vessels and mainly to the iliac and para-aortic lymph nodes.

Innervation

- **The inferior hypo-gastric plexuses innervate bladder and contain sympathetic post-ganglionic fibres (from L1 and L2).**
- **Pre-ganglionic parasympathetic fibres form part of the plexus via the splanchnic nerves (S2–4).**
- **These pre-ganglionic fibres synapse with the post-ganglionic fibres in the inferior hypogastric plexus.**
- **The pelvic splanchnic nerves also carry afferent sensory fibres to the CNS. Other afferent sensory fibres are transmitted, via the inferior hypogastric plexus, to the L1 and L2 segments.**

Male Urethra

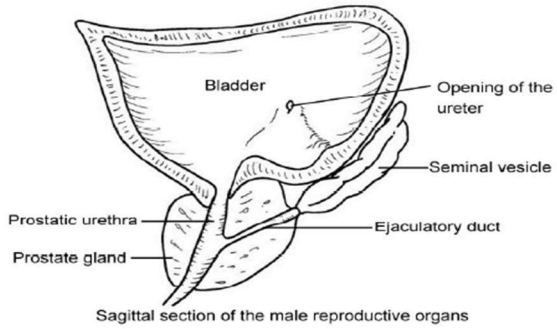
It is a long tube of 20 Cm. in length. It starts at the neck of the bladder by internal urethral orifice that acts as a sphincter. It ends at the glans of penis by external urethral opening. Four anatomic divisions, preprostatic, prostatic, membranous, and penile parts:

■Preprostatic part : lies within the neck of the urinary bladder.

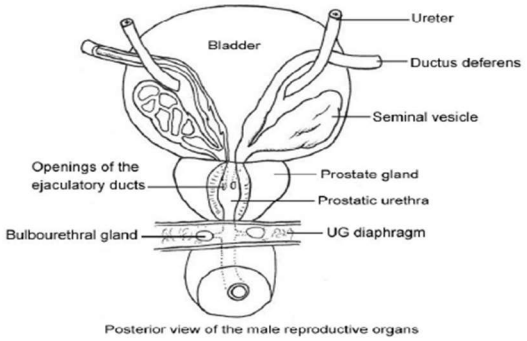
■Prostaticpart (3Cm.): Passes through the prostate gland, where it receives semen from the ejaculatory ducts (union of vas deferens and duct of the seminal vesicle). The prostate gland itself also contributes prostatic fluid to the ejaculate via several prostatic ducts. Lined by transitional epithelium. Prostate surrounds the urethra just below the bladder. Stores and secretes an alkaline fluid constituting over 25% of semen volume. The vas deferens joins the duct of the seminal vesicle to become the ejaculatory duct, which courses through the prostate before emptying into the urethra.

■ Membranous part is the shortest part (one Cm.): Surrounded by striated muscle, which forms the voluntary external urethral sphincter (weakness produces urinary incontinence). Viscous secretions from the bulbourethral glands enter here.

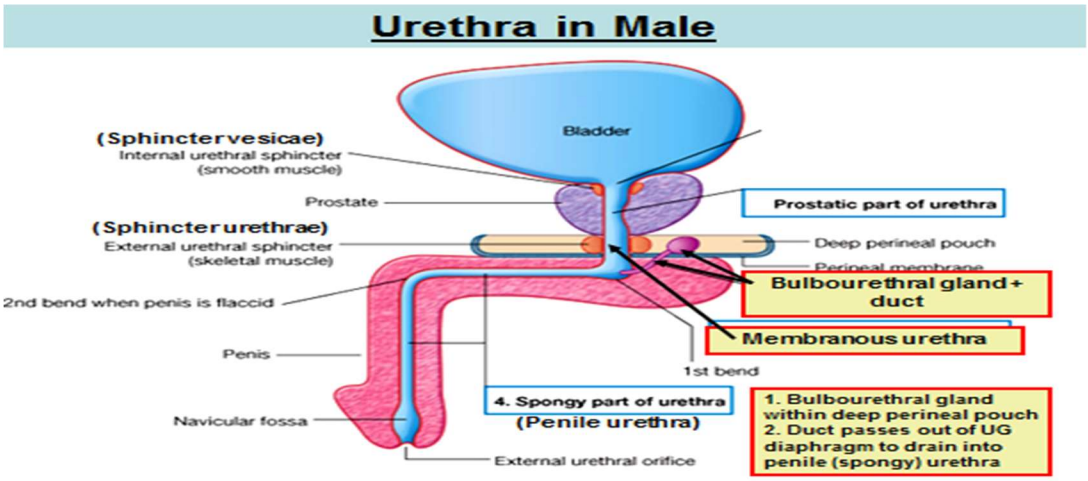
■ Penile part is the longest part (16 Cm.): (including bulbous and pendulous sections): Longest segment, travels through the corpus spongiosum. Surrounded by Littre glands, which secrete mucus that is incorporated into the semen. Lined by pseudo-stratified columnar epithelium proximally, stratified squamous epithelium distally.



Sagittal section of the male reproductive organs



Posterior view of the male reproductive organs



Female Urethra

- **Much shorter than the male urethra (of about 4 Cm).**
- **It is lined by stratified squamous and pseudo-stratified columnar epithelium. At its midportion, it is surrounded by the striated muscle of the voluntary external urethral sphincter. The female urethra is also surrounded by Littre glands.**