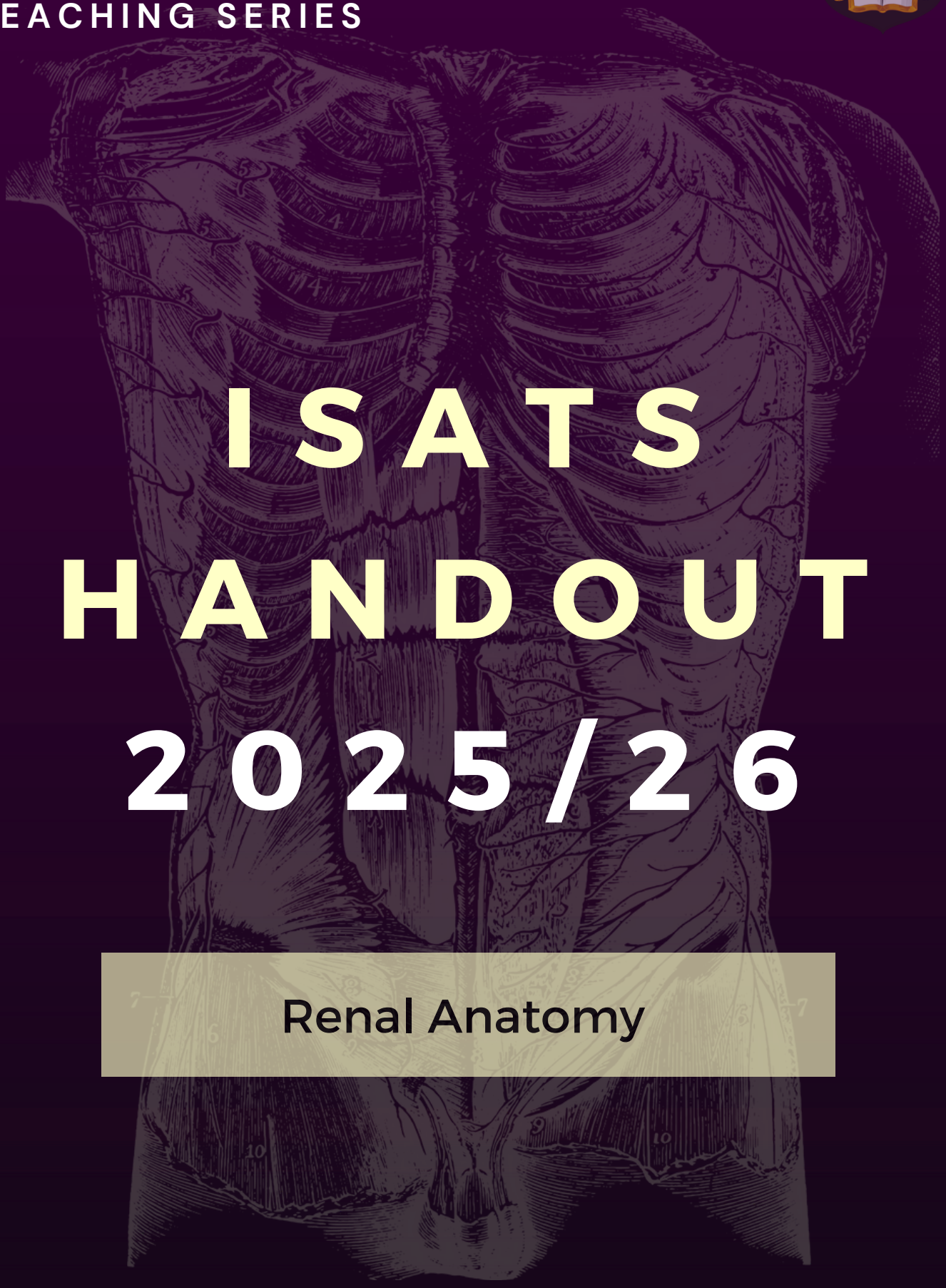
INTERNATIONAL
SURGICAL ANATOMY
TEACHING SERIES



ISATS HANDOUT 2025/26

Renal Anatomy

High Yield | Surgical Relevance | Approved for CPD points

RENAL ANATOMY & UROLOGY

Objectives: *Objectives: Understand the anatomy of the kidneys, ureters, bladder, urethra, the male reproductive system and their respective neurovascular supply. Apply anatomical knowledge in context of common urological procedures*

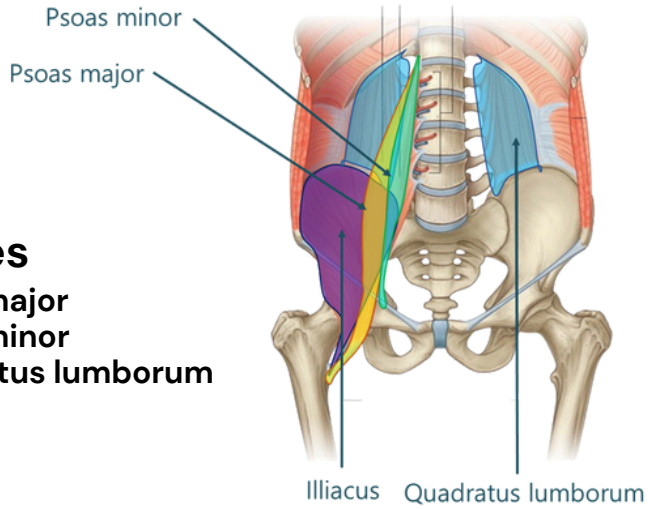
Posterior Abdominal Wall

Important Structures

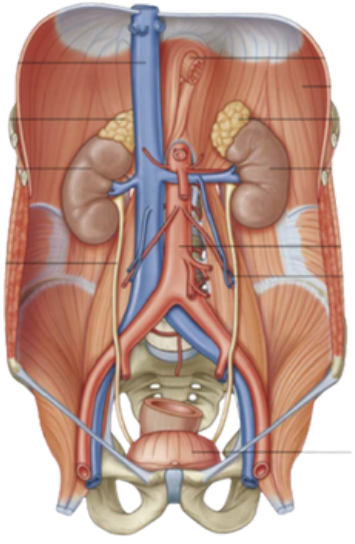
- **Posterior abdominal wall skeleton**
- **Muscles**
- **Lymphatics**
- **Vasculature:**
  - **Abdominal aorta**
  - **Inferior vena cava**
- **Innervation:**
  - **Sympathetic trunks**
  - **Lumbar plexus**

Muscles

- **Psoas major**
- **Psoas minor**
- **Quadratus lumborum**
- **Iliacus**



Muscle	Origin	Insertion
Psoas major	• **Lateral surfaces of T12, L1-L5 vertebrae & discs**	○ **Lesser trochanter of femur**
Psoas minor	• **Lateral surfaces of T12, L1-L5 vertebrae & discs**	○ Pelvic brim, iliopubic eminence
Quadratus lumborum	• Transverse process of L5, iliac crest, iliolumbar ligament	○ Transverse processes L1-L4, inferior border of rib 12
Iliacus	• Iliac fossa, sacroiliac and iliolumbar ligaments, upper sacrum	○ **Lesser trochanter of femur**

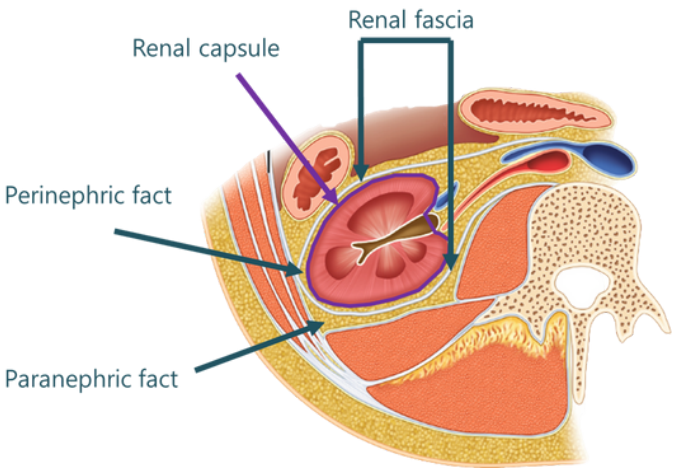


Urinary System

- **Kidneys**
- **Ureters**
- **Bladder**
- **Urethra**

The Kidneys

- **Retroperitoneal**
- **Immediately lateral to vertebrae**
- **T12 – L3**
- **Encapsulated by renal fascia**



Filters blood, removes waste and excess water

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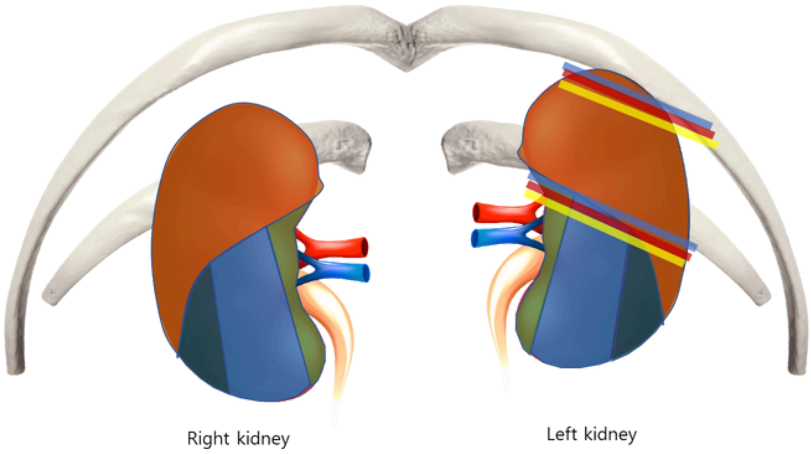
The Kidneys

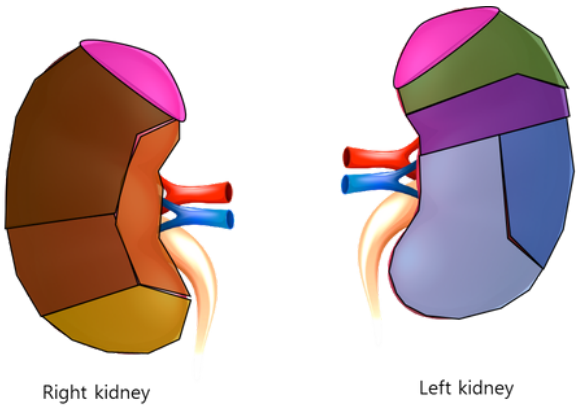
Posterior relations:

- Superior: diaphragm
- Medial to lateral:
  - Psoas major
  - Quadratus lumborum
  - Transversus abdominis
- Ribs
  - + subcostal bundle



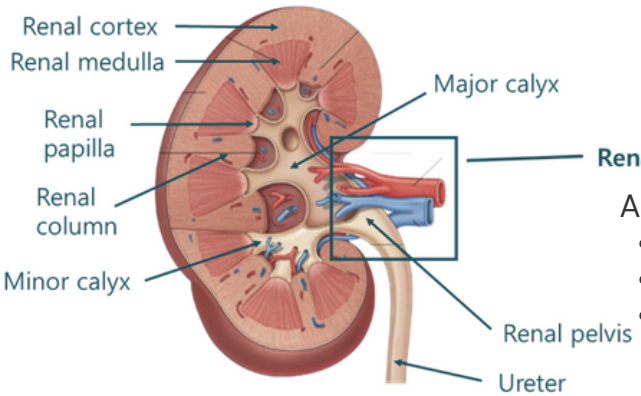
Anterior relations:

- Superior: suprarenal glands
- Right kidney:
  - Liver
  - Descending duodenum
  - Right colic flexure
  - Small intestine
- Left kidney:
  - Stomach and spleen
  - Pancreas
  - Left colic flexure and descending colon
  - Jejunum



Structure

- Outer renal cortex
- Inner renal medulla
- Renal papilla
- Renal column
- Minor renal calyx
- Major renal calyx
- Renal pelvis
- Ureter
- Hilum of kidney



Anterior to posterior:

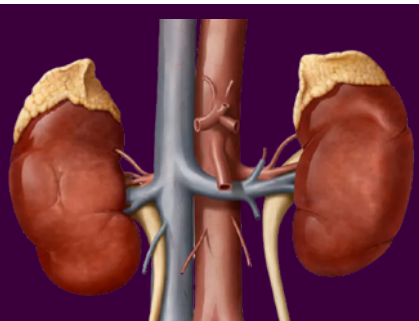
- Renal vein
- Renal artery
- Renal pelvis

Arterial Supply

- **Renal arteries** (abdominal aorta)
  - Just inferior of SMA (between L1 & L2)
  - Right artery > left artery
  - Divides into anterior and posterior branches at hilum
  - Accessory arteries are common

Venous drainage

- **Renal veins** (IVC)
  - Anterior to renal arteries
  - Left vein > right vein
    - Anterior to aorta
    - Posterior to SMA
    - Aneurysms = nutcracker



RENAL ANATOMY & UROLOGY

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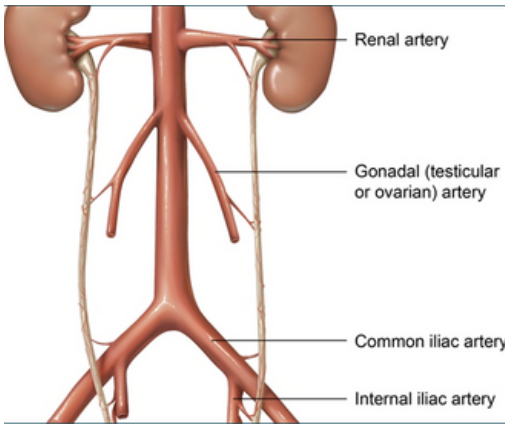
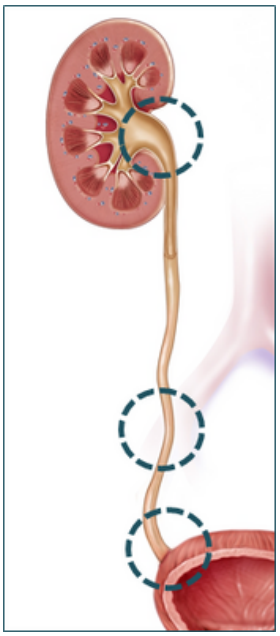
Ureters

- **Muscular tubes transporting urine to the bladder**
  - Continuous with renal pelvis
  - 3 major points of constriction
    - Ureteropelvic junction
    - Pelvic inlet
    - Ureterovesical junction
  - **Clinical implication**: stones!

- **3 parts:**
  - Abdominal ureter
  - Pelvic ureter
  - Intravesical / intramural
- Receiving vascular supply from nearby major arteries





Minor calices → **Major calices** → **Renal pelvis** → **Ureters**

BLADDER

- Most anterior pelvic organ
- 3-sided pyramid
  - Apex
  - Body
  - Fundus
  - Neck

Innervation

- Hypogastric nerve
  - T12-L2
  - Sympathetic
  - **Relaxes** detrusor
  - Urine retention

- Pelvic splanchnic nerve
  - S2-S4
  - Parasympathetic
  - **Contracts** detrusor
  - Micturition

- Pudendal nerve
  - Voluntary, somatic
  - **Control**: External urethral sphincter

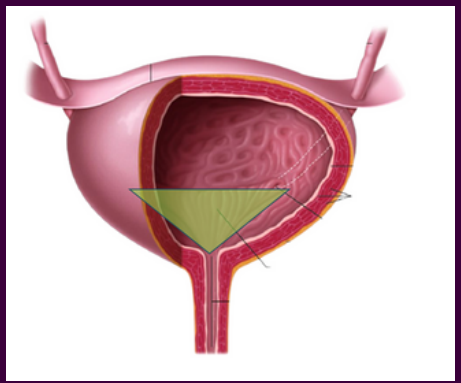
- Trigone = smooth area
  - Formed by ureteric orifices and internal urethral orifice
- Detrusor muscle - smooth muscle
- Internal urethral sphincter
  - Smooth muscle
  - Continuous with detrusor

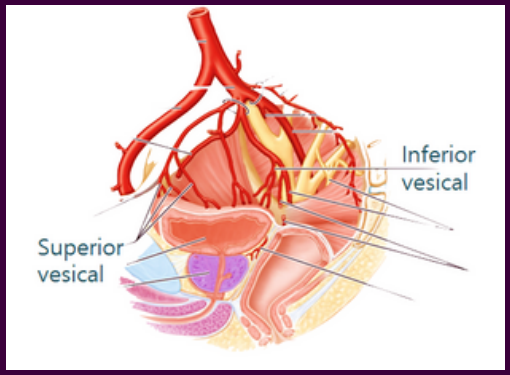
Arterial supply

- Upper part:
  - Superior vesical branches (internal iliac)
- Lower part:
  - **Male:** inferior vesical branches
  - **Female:** vaginal arteries

Venous drainage

- Network of vesical veins
- Draining into internal iliac





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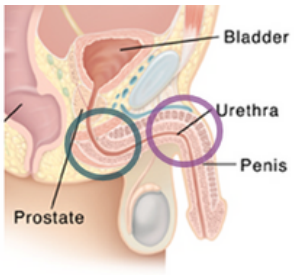
Urethra

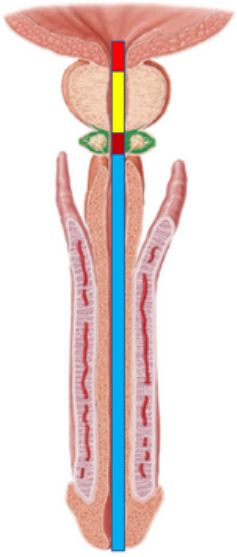
- **Begins at the base of the bladder - surrounded by internal urethral sphincter**
- **Ends with external urethral orifice**
- **Women:**
  - Short (4cm)
  - Anterior to vaginal opening
  - **Skene's glands** - lubrication
- **Men:**
  - Long (20cm)
  - Bends twice
  - **4 parts**

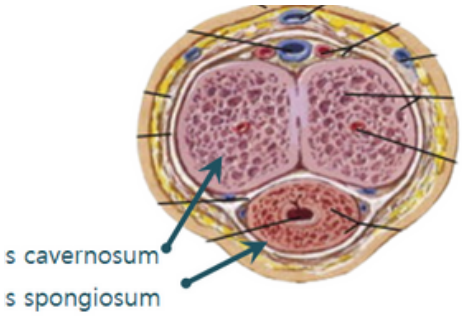


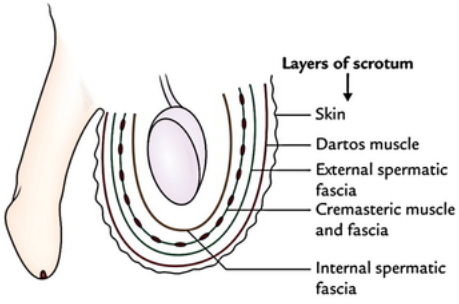
Prepubic angle Infrapubic angle

Parts of the male urethra

- **Pre-prostatic**
  - Short (4cm)
  - Anterior to vaginal opening
- **Prostatic**
  - Several openings: ejaculatory ducts, prostatic ducts
- **Membranous**
  - Through deep perineal pouch
  - Narrowest part
  - Passes through external urethral sphincter
- **Spongy**
  - Surrounded by erectile tissue
  - Distal navicular fossa







Male Reproductive System

- **Testes**
- **Epididymis**
- **Vas deferens**
- **Ejaculatory ducts**
- **Accessory glands:**
  - Prostate
  - Paired seminal vesicles
  - Paired bulbo-urethral glands

Prostate

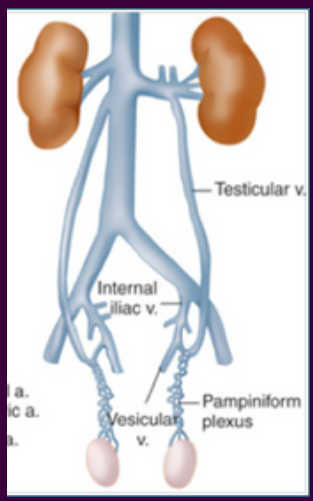
- Unpaired accessory structure
- Surrounds the prostatic urethra
- Discrete zones:
  - **Transitional zone** = BPH
  - **Peripheral zone** = Prostate cancer

Testes

- Develop in the abdomen
- Descends through inguinal canal
- Covered by peritoneal sac

Testes - Neurovascular Supply

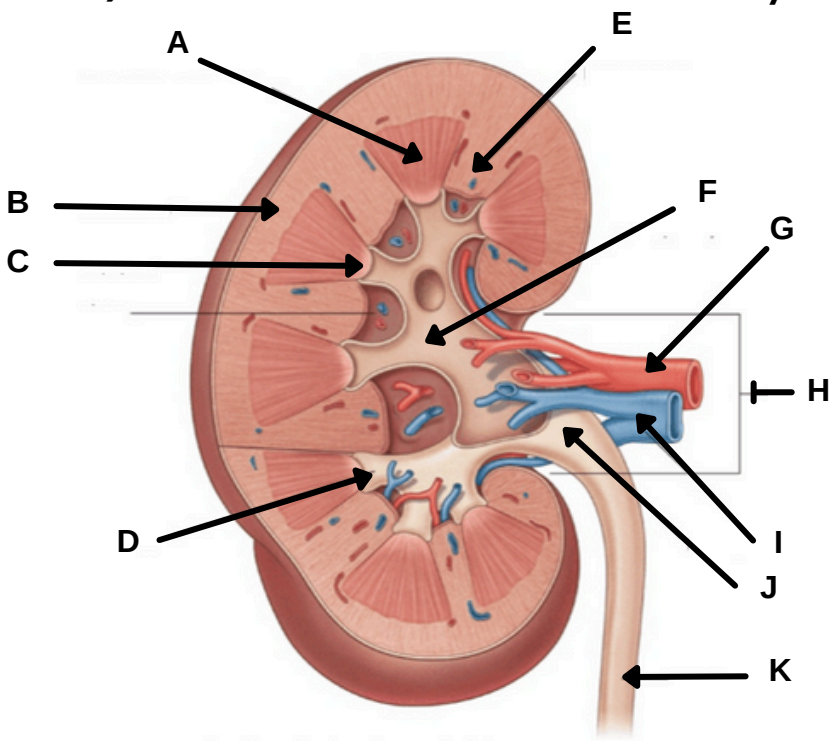
- **A** - testicular arteries (abdominal aorta) + cremasteric artery + artery of vas deferens
- **V** - testicular veins
- **N** - testicular plexus
- **L** - lumbar and para-aortic nodes



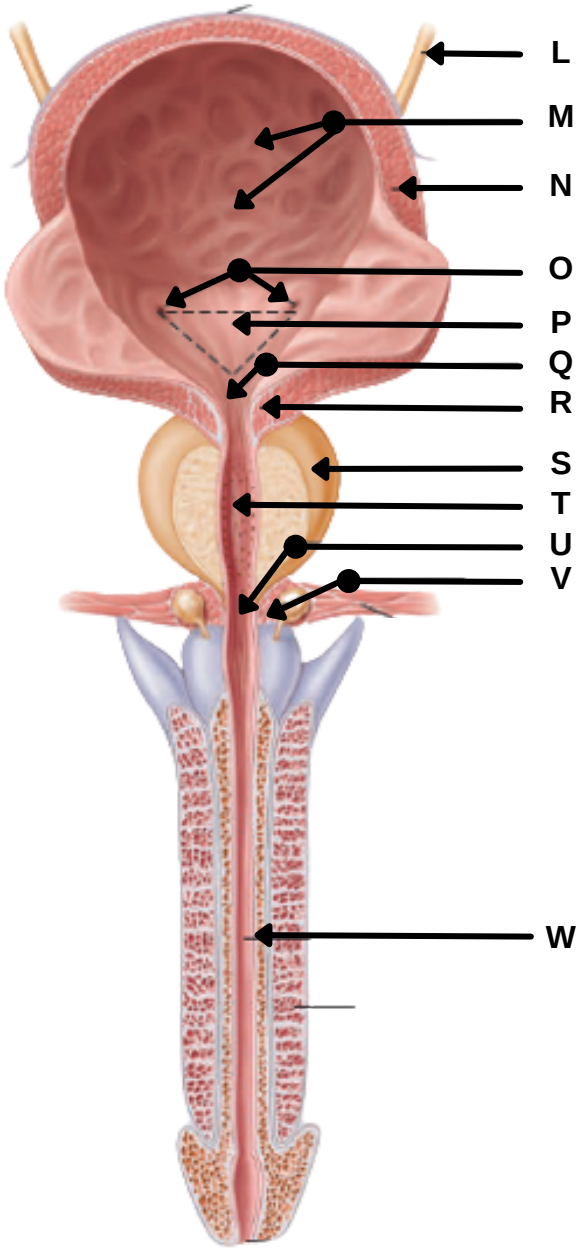
RENAL ANATOMY & UROLOGY

Test yourself

1) Label the structures of the kidney



2) Label the structures of the bladder and parts of the male urethra



RENAL ANATOMY & UROLOGY

Test yourself

MCQ 1
The left renal vein passes between which two major vessels, making it prone to "nutcracker syndrome"?

A. Aorta and inferior vena cava
B. Superior mesenteric artery and aorta
C. Left common iliac artery and aorta
D. Inferior mesenteric artery and aorta
E. Splenic vein and pancreas

MCQ 2
Which is the narrowest part of the male urethra?

A. Pre-prostatic
B. Prostatic
C. Membranous
D. Spongy
E. Navicular fossa

MCQ 3
A 65-year-old male presents with painless visible haematuria. Which of the following is the most appropriate first-line investigation?

A. PSA blood test
B. Renal ultrasound
C. Cystoscopy
D. CT urography
E. Urine cytology

MCQ 4
Which artery most commonly gives accessory branches to the ureter in the abdomen?

A. Renal artery
B. Gonadal artery
C. Common iliac artery
D. Internal iliac artery
E. Inferior mesenteric artery

MCQ5
Which zone of the prostate is most commonly affected by carcinoma?

A. Central zone
B. Peripheral zone
C. Transitional zone
D. Anterior fibromuscular stroma
E. Median lobe

MCQ 6
A 40-year-old man presents with colicky flank pain radiating to the groin. CT KUB confirms a stone at the ureterovesical junction. What is the most likely additional symptom?

A. Dysuria and urinary frequency
B. Left shoulder tip pain
C. Testicular pain on the same side
D. Haematemesis
E. Perianal numbness

RENAL ANATOMY & UROLOGY

Test yourself

OSCE Station - Case Based Discussion

A 55-year-old man presents to clinic with a 3-month history of painless visible haematuria. He has no dysuria or fever. He is a lifelong smoker and worked in the dye industry.

Q1. What are the most important differential diagnoses to consider?

Q2. What is the single most important first-line investigation?

Q3. What additional investigations are typically performed to stage the condition if malignancy is found?

Q4. Name two risk factors from this patient's history.

Q5. What are the main surgical treatment options for bladder cancer?

Answers
Labels 1: A = renal pyramid / renal medulla, B = renal cortex, C = renal papilla, D = minor calyx, E = renal column / renal cortex, F = major calyx, G = renal artery H = renal hilum, I = renal vein , J = renal pelvis, K = ureter;
Labels 2: L = (left) ureter, M = rugae/ bladder wall, N = detrusor, O = ureteric orifices, P = trigone, Q = internal urethral orifice, R = internal urethral sphincter, S = prostate, T = prostatic urethra, U = membranous urethra , V = external urethral sphincter, W = spongy urethra, X = erectile tissue

MCQs.
1) B – Between SMA and aorta
2) C – Membranous urethra
3) C – Cystoscopy
4) A – Renal artery
5) B – Peripheral zone
6) C – Testicular pain on same side

A1. Bladder cancer (most likely), renal cell carcinoma, prostate cancer, UTI, renal/ureteric stones.
A2. Flexible cystoscopy.
A3. CT urography ± CT chest/abdomen/pelvis for staging; urine cytology.
A4. Smoking, occupational exposure (aromatic amines in dye industry).
A5. – Transurethral resection of bladder tumour (TURBT) ± intravesical therapy
– Radical cystectomy ± urinary diversion (invasive disease)