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INTERNATIONAL  
SURGICAL ANATOMY  
TEACHING SERIES



**ISATS**  
**HANDOUT**  
**2024/25**

Renal Anatomy

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High Yield | Surgical Relevance | CPD Accredited

# 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

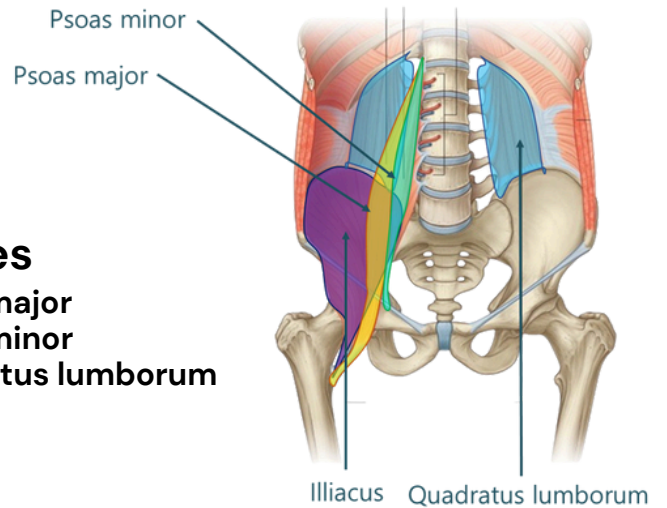
## Posterior Abdominal Wall

### Important Structures

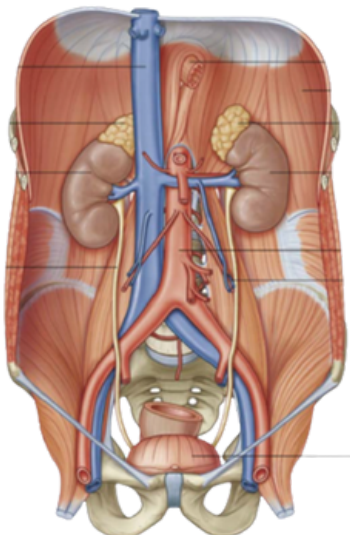
- Posterior abdominal wall skeleton
- Muscles
- Lymphatics
- Vasculature:
  - Abdominal aorta
  - Inferior vena cava
- Innervation:
  - Sympathetic trunks
  - Lumbar plexus

### 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                            |

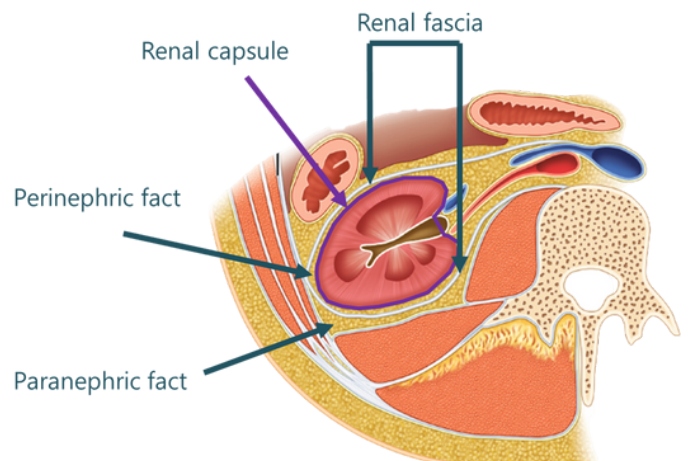


## Urinary System

- Kidneys
- Ureters
- Bladder
- Urethra

## The Kidneys

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



**Filters blood, removes waste and excess water**

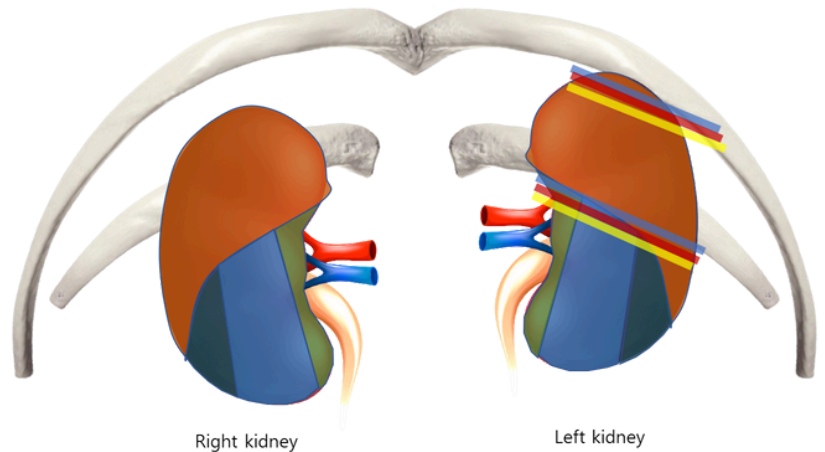
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## The Kidneys

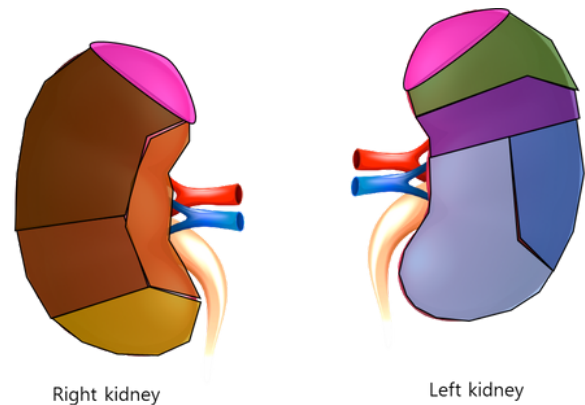
### Posterior relations:

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



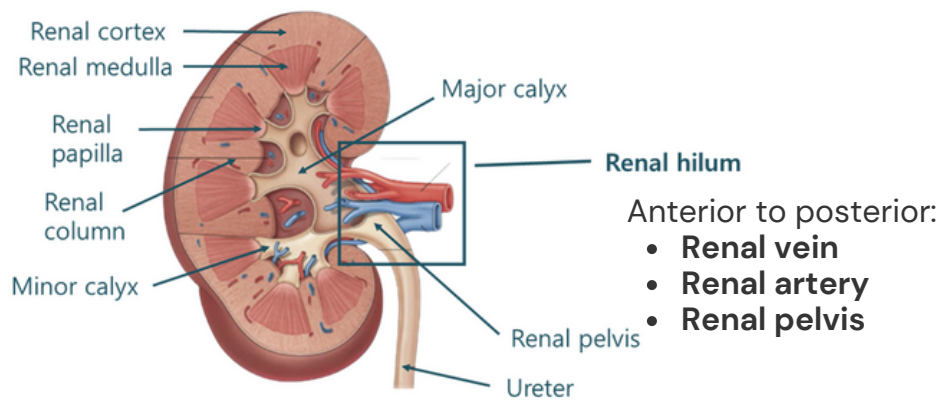
### Anterior relations:

- 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

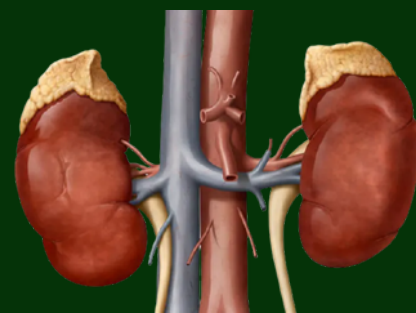


## Arterial Supply

- **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

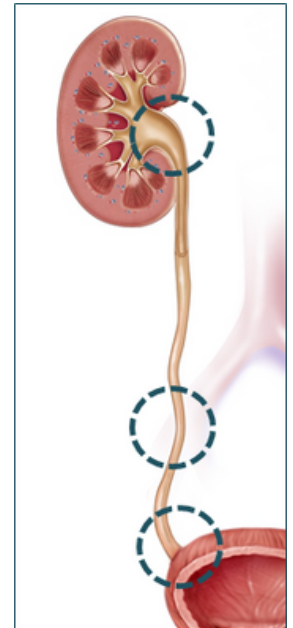
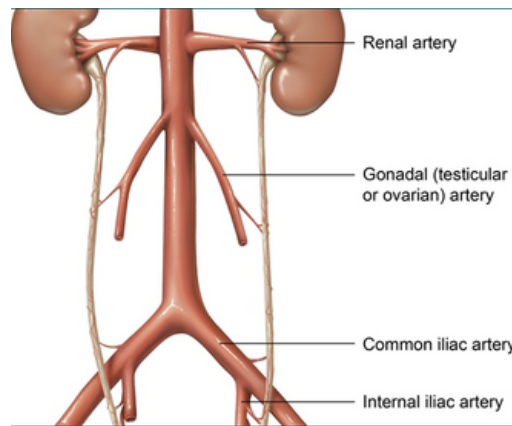


# RENAL ANATOMY & UROLOGY

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## Ureters

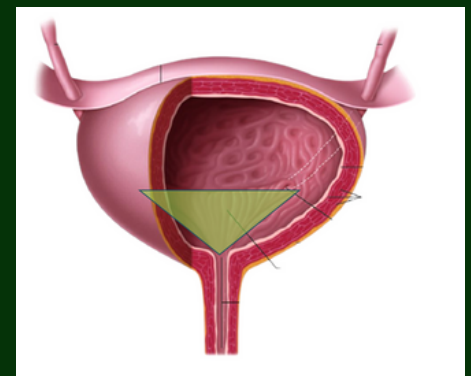
- **Muscular tubes transporting urine to the bladder**
  - Continuous with renal pelvis
  - 3 major points of constriction
    - Ureteropelvic junction
    - Pelvic inlet
    - Ureterovesical junction
  - **Clinical implication:** stones!
- **3 parts:**
  - Abdominal ureter
  - Pelvic ureter
  - Intravesical / 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
- Trigone = smooth area
  - Formed by ureteric orifices and internal urethral orifice
- Detrusor muscle – smooth muscle
- Internal urethral sphincter
  - Smooth muscle
  - Continuous with detrusor



### Innervation

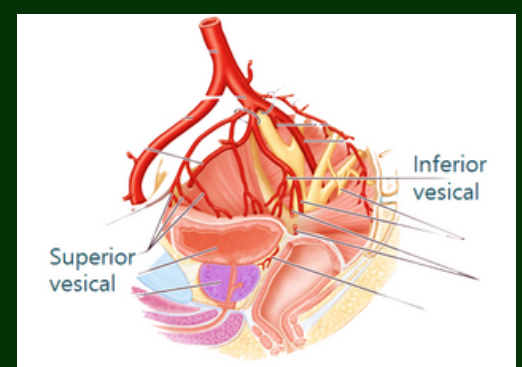
- Hypogastric nerve
  - T12–L2
  - Sympathetic
  - **Relaxes** detrusor
  - Urine retention
- Pelvic splanchnic nerve
  - S2–S4
  - Parasympathetic
  - **Contracts** detrusor
  - Micturition
- Pudendal nerve
  - Voluntary, somatic
  - **Control:** External urethral sphincter

### 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

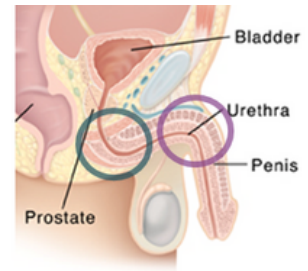


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## Urethra

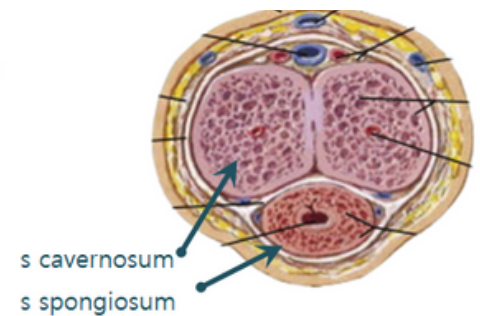
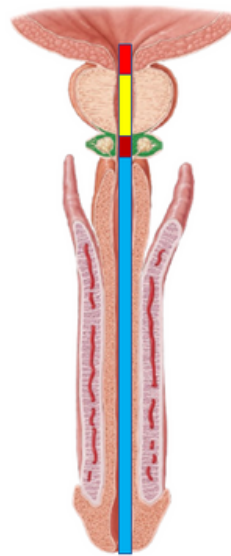
- Begins at the base of the bladder – surrounded by internal urethral sphincter
- Ends with external urethral orifice
- Women:
  - Short ( 4cm)
  - Anterior to vaginal opening
  - **Skene's glands** – lubrication
- Men:
  - Long ( 20cm)
  - Bends twice
  - **4 parts**



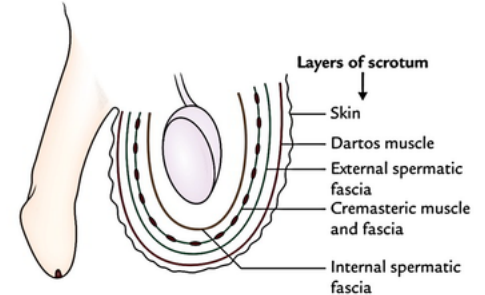
Prepubic angle      Infrapubic angle

## 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



s cavernosum  
s spongiosum



Layers of scrotum

## Male Reproductive System

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

### Prostate

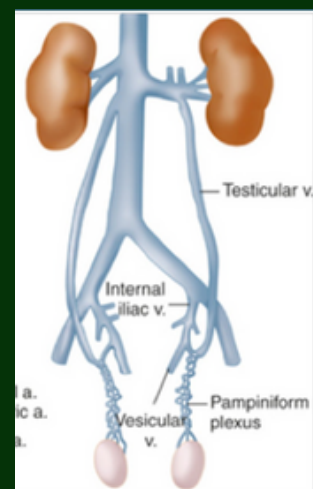
- Unpaired accessory structure
- Surrounds the prostatic urethra
- Discrete zones:
  - **Transitional zone** = BPH
  - **Peripheral zone** = Prostate cancer

### Testes

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

### Testes – Neurovascular Supply

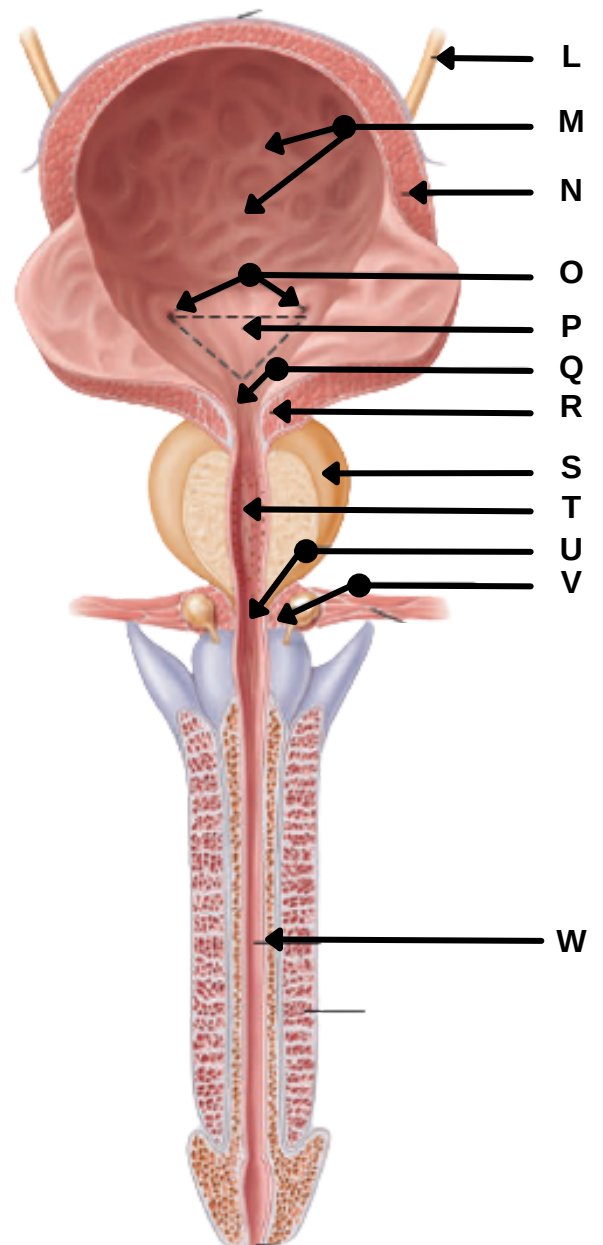
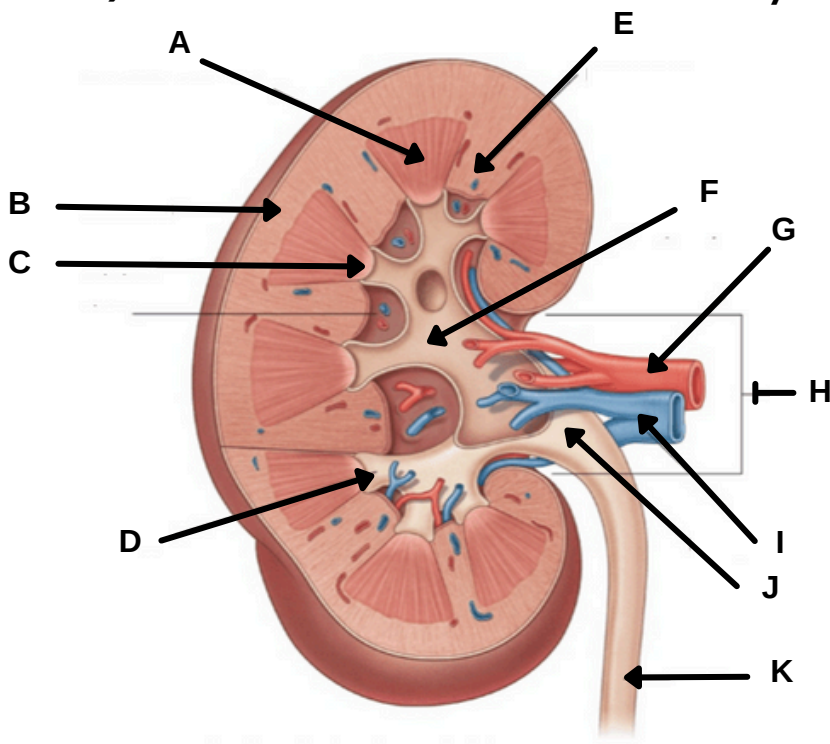
- **A** – testicular arteries (abdominal aorta) + cremasteric artery + artery of vas deferens
- **V** – testicular veins
- **N** – testicular plexus
- **L** – lumbar and para-aortic nodes



# 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

Which rib(s) does the right kidney lie deep to?

- A. XI, XII
- B. X, XI
- C. XII
- D. The kidney lies inferior to all ribs
- E. IX, X

### MCQ 2

During which aspect of micturition would somatic innervation by the pudendal nerve play a role?

- A. Contraction of detrusor muscle
- B. Relaxation of internal urethral sphincter
- C. Relaxation of external urethral sphincter
- D. Detrusor relaxation
- E. Contraction of bladder outlet

### MCQ 3

You are a clinician who has been asked to insert a urinary catheter into a male patient. Which is the correct order of parts of the urethra that the catheter will pass?

- A. Pre-prostatic, prostatic, membranous, spongy + navicular fossa
- B. Spongy + navicular fossa, membranous, pre-prostatic,
- C. Membranous, pre-prostatic, prostatic, navicular fossa, spongy
- D. Navicular fossa + membranous, prostatic, pre-prostatic
- E. Bulbourethral, perineal, spongy, prostatic

### MCQ 4

A patient presents with renal colic and haematuria. Non-contrast CT detects a kidney stone which is lodged in the most proximal narrowing of the ureter. Where is the stone?

- A. Ureterovesical junction
- B. Renal pelvis
- C. Pelvic inlet
- D. Ureter-testicular artery cross-point
- E. Ureteropelvic junction

### MCQ5

From superficial to deep, what are the layers of the scrotum?

- A. Skin, dartos muscle, external spermatic fascia, cremasteric muscle and fascia, internal spermatic fascia, tunica vaginalis
- B. Skin, tunica albuginea, tunica vaginalis, dartos muscle, cremaster muscle, internal spermatic fascia
- C. Skin, external spermatic fascia, cremasteric muscle, internal spermatic fascia, dartos muscle,
- D. Skin, cremasteric muscle, external spermatic fascia, dartos muscle, internal spermatic fascia, tunica vaginalis

### MCQ 6

Which surrounding tissue lies immediately superficial to the kidney

- A. Perinephric fat
- B. Paranephric fat
- C. Renal fascia
- D. Renal capsule
- E. Transversalis fascia

# RENAL ANATOMY & UROLOGY

## Test yourself

### OSCE Station – Case Based Discussion

A 75-year old male patient presents to the outpatient clinic complaining of having to get up around five times a night to pass urine. Whilst he feels the need to go urgently, he can't seem to start passing urine immediately. Afterwards he finds he continues to dribble. His wife is concerned for him due to the effect on his sleep. The following questions relate to the investigations and management of this patient.

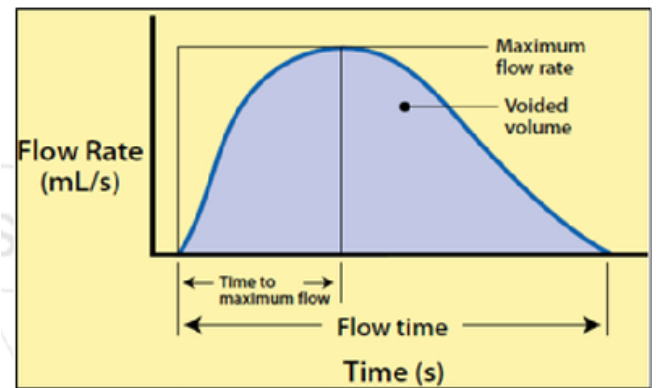


Figure 1: Schematic of a normal flow curve

- Q1. What would be the initial management of this patient?
- Q2. What are the potential differential diagnoses from this presentation?
- Q3. Which investigations will be useful in confirming a diagnosis?
- Q4. How will you conservatively manage this patient?
- Q5. What is the potential medical management for this case?
- Q6. What are the surgical management options and potential complications of these?

**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, renal cortex, 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) C, (2) C, (3) B, (4) E, (5) A, (6) D  
**OSCEs:** (1) Detailed history, including medication review, examination of abdomen, external genitalia and DRE. (2) Benign prostatic enlargement/hyperplasia, prostate cancer, UTI, prostatitis, chronic urinary retention, bladder cancer, urethral stricture (3) Urine frequency-volume chart (normal findings pictured above), urine dipstick to detect blood, glucose, protein, leukocytes, nitrites. PSA (only if suspected cancer or bladder outlet obstruction, requires counselling), flow-rate assessment in specialist review (Q4) Lifestyle advice regarding fluid intake, urethral milking and pads (5) Alpha-blocker eg. tamsulosin, 5-alpha reductase inhibitor, consider late afternoon loop diuretic (6) Transurethral resection of the prostate, monopolar transurethral vaporisation of the prostate, holmium laser enucleation of the prostate. S/E: Hyponatraemia/TURP syndrome, retrograde ejaculation, erectile dysfunction, urinary incontinence, urethral stricture