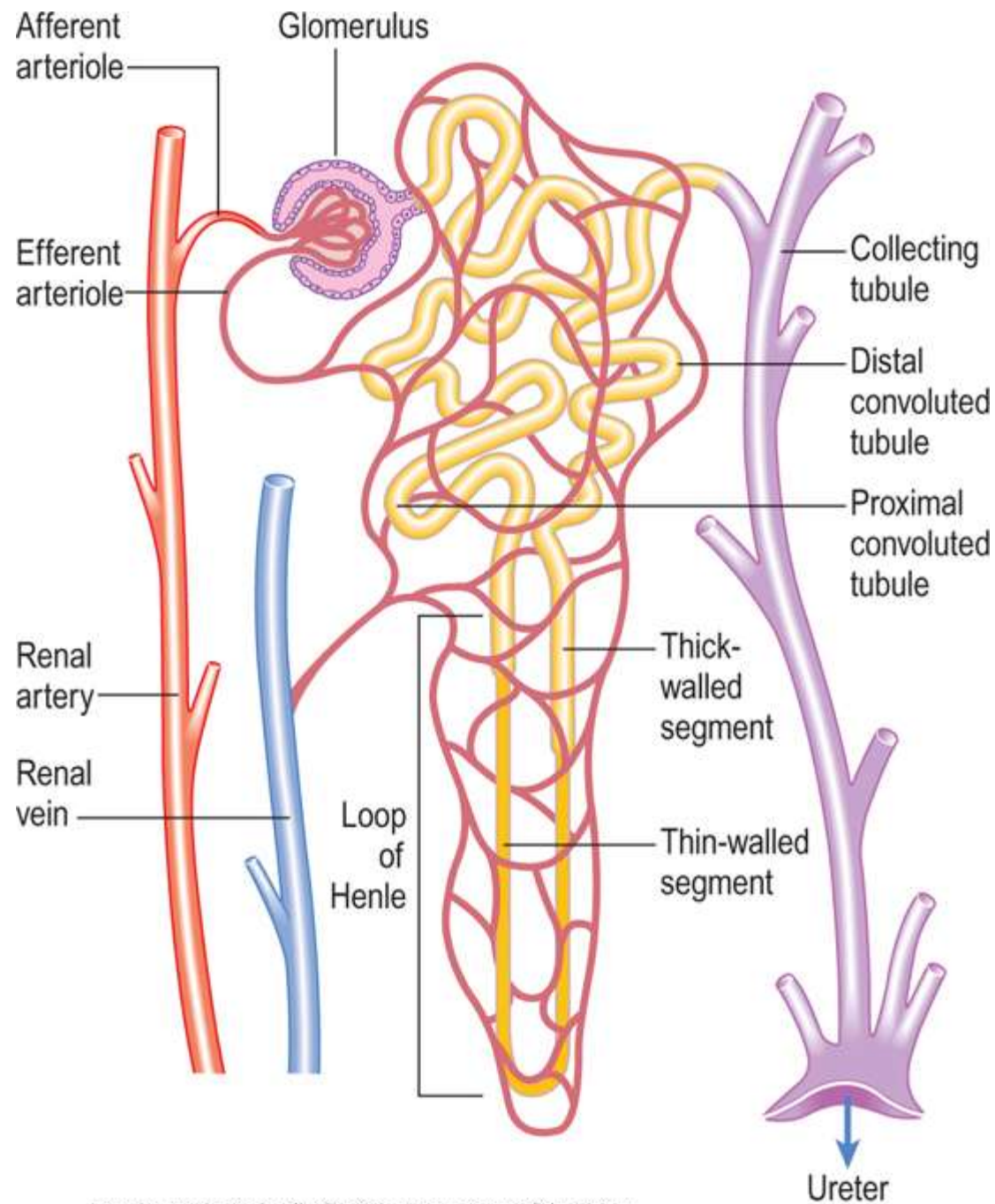
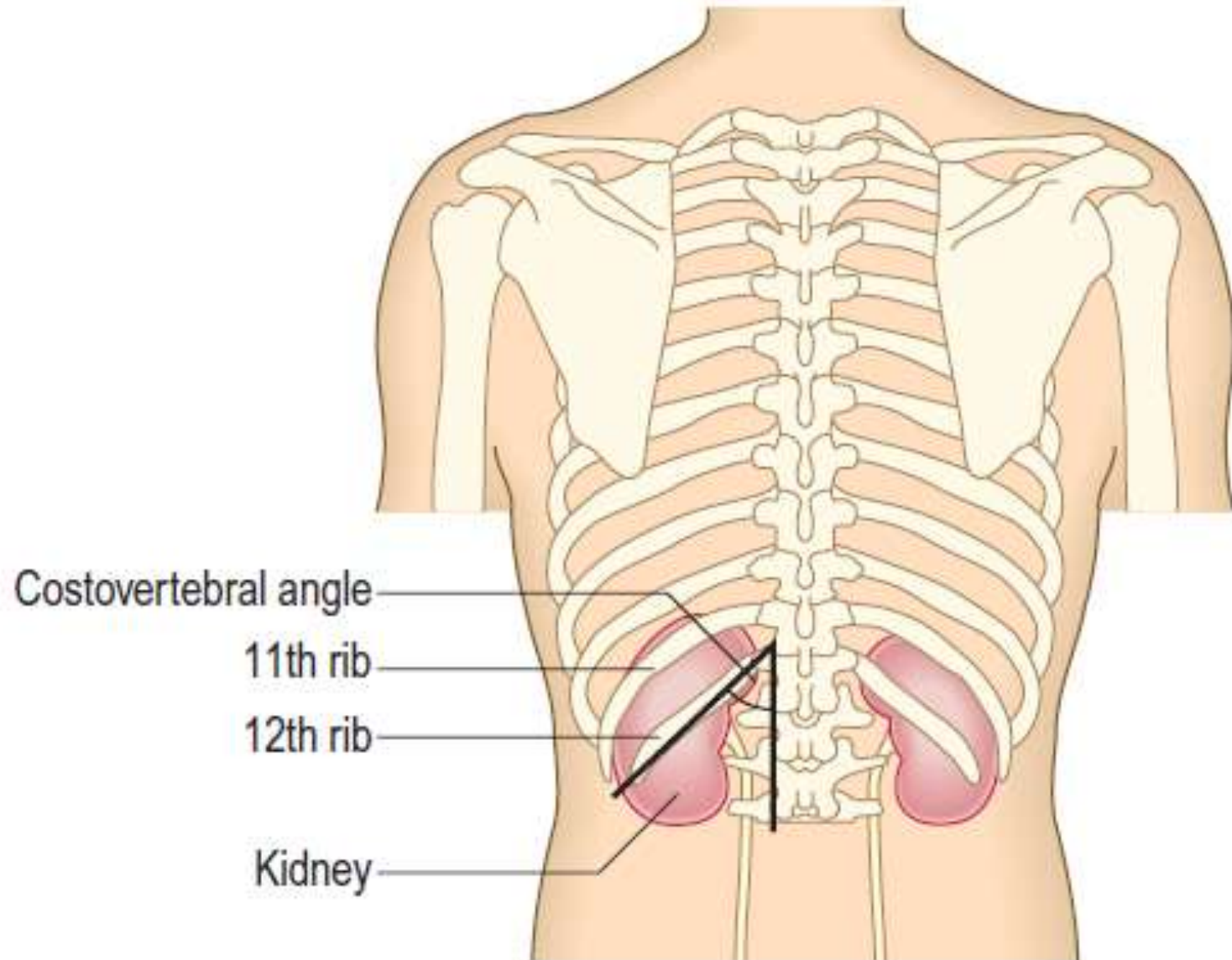


# The Renal System

# Anatomy

- Retroperitoneal , T12–L3 level and are 11–14 cm long.
- The right kidney lies 1.5 cm lower → **liver**.
- The kidneys move downwards during inspiration as the lungs expand.
- kidneys receive ~25% of cardiac output.
- Each kidney contains about one million nephrons.





# Function

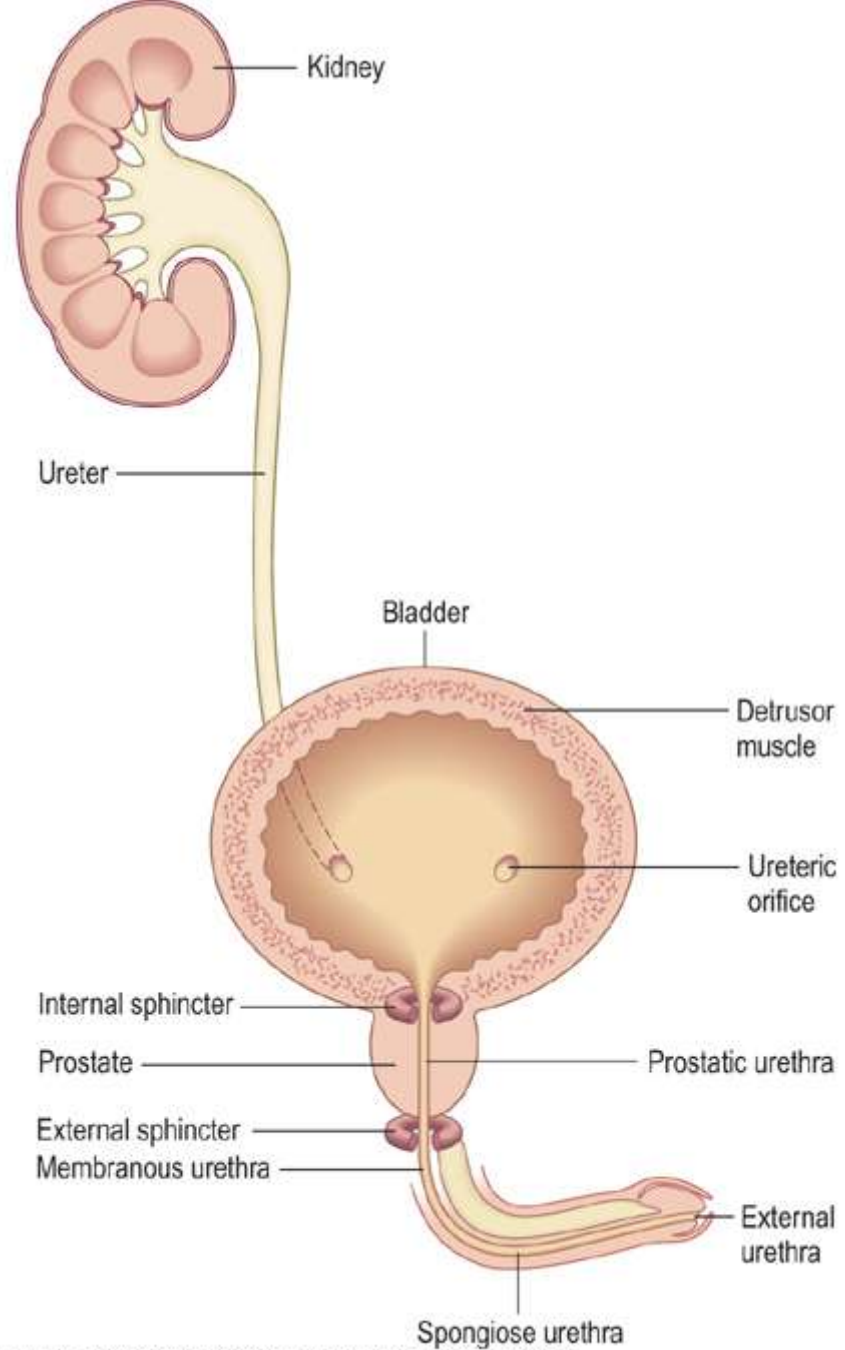
- **excretion** of waste products of metabolism
- maintaining salt, **water and electrolyte** homeostasis
- regulating **blood pressure** via the renin–angiotensin system
- **endocrine** functions related to **erythropoiesis** and **vitamin D** metabolism.

The **bladder** → reservoir. As it fills, it rises out of the pelvis in the midline towards the umbilicus.

The bladder wall contracts under parasympathetic control, allowing urine to pass through the urethra (micturition).

The conscious desire to micturate occurs when the bladder holds ~ **250–350** ml of urine.

Renal capsule and ureter are innervated by T8- L2 nerve root



# Anatomy

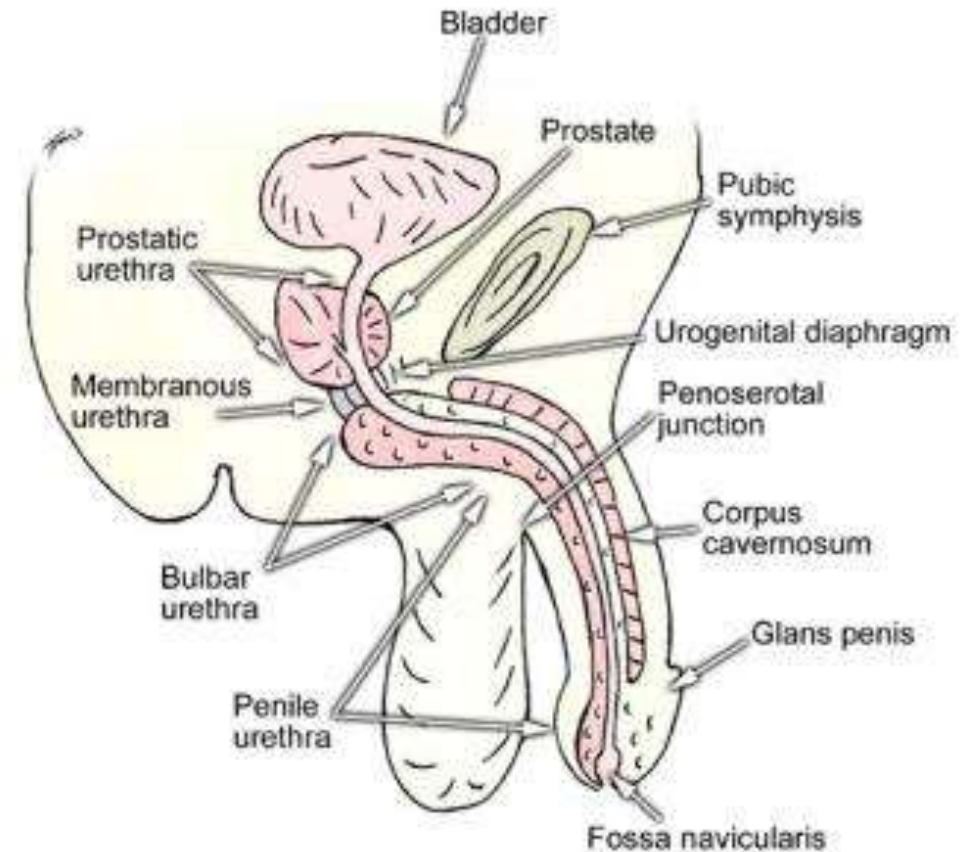
The male urethra runs from the bladder to the tip of the penis:

1. Prostatic urethra
2. Membranous
3. Bulbar
4. penile

• **The female urethra is much shorter.**

Two muscular rings acting as valves (sphincters) control micturition:

- The **internal sphincter** is at the bladder neck and is involuntary.
- The **external sphincter** surrounds the membranous s2-4





# Symptoms and Definitions

- Severe renal disease may be **asymptomatic**, or have **nonspecific** symptoms, such as tiredness or breathlessness from renal failure or associated anemia. poor appetite, sleep disturbance, etc...
- **Growth retardation** is common with CKD in childhood.
- Detection often follows **incidental testing of blood and urine.**

- **Dysuria:** (voiding pain) is pain during or immediately after passing urine, often described as a 'burning' sensation felt at the urethral meatus.
- Ask about : associated symptoms(cystitis) /systemic symptoms( pyelonephritis )/ urine outflow obstruction symptoms/ sexual contacts
- Prostatitis may cause perineal and rectal pain at the same time.

# Loin Pain

It has multiple differential diagnosis such as

Urinary tract diseases such as , pyelonephritis , kidney stone, ureteic stones .. etc

Musculoskeletal such as muscle spasm, trauma .. Etc.

Gastrointestinal diseases

Gynecological diseases such as ruptured ectopic pregnancy, Ovarian torsion

Vascular such as Ruptured Abdominal aortic aneurysm

# Loin pain

- Loin pain caused by urinary tract diseases can be divided into acute obstruction of the urinary tract or parenchymal cause of pain

Acute obstruction of the urinary tract pain is called the renal or ureteric colic pain which is caused most commonly due to stones but can be caused also by other causes such as obstructing blood clot

Parenchymal cause of pain such as infection or inflammation such as acute pyelonephritis

# Loin pain

Renal or ureteric colic :

- **Site** – unilateral, in the renal angle and flank area
- **Onset** – sudden
- **Character** – usually very severe may vary cyclically in intensity **mainly it is colicky**
- **Radiation** – may radiate to the iliac fossa, the groin and the genitalia/ testes
- **Associated** features – patient is usually **restless** and **nauseated**, and often **vomits**
- **Timing** – **mainly colicky**.
- **Exacerbating/relieving** factors – analgesia
- **Severity** –often very severe .

# Loin pain

- Parenchymal pain

Is mainly dull constant pain and varies in severity

# Voiding symptoms

Lower urinary tract symptoms may be:

- during the storage phase of micturition
- during the voiding phase of micturition
- incontinence

# Storage symptoms

- **Frequency** is a desire to pass urine more often than usual ((more than 7 times per day))

Another definition: is complaint that micturition occurs more frequently during waking hours than previously deemed normal by the patient

- **Urgency** – a sudden (**Compelling**) strong need to pass urine **that cannot be deferred** .

Urgency is due to either overactivity in the detrusor muscle or abnormal stretch receptor activity from the bladder (sensory urgency).

- **Nocturia** – waking one or more at night to **void preceded by sleeping and followed by intention getting back to sleep** .

Storage symptoms are usually associated with bladder, prostate or urethral problems, e.g. **lower urinary tract infection, tumour, urinary stones or obstruction from prostatic enlargement**, or are a consequence of neurological disease.



# Voiding phase symptoms

- **Hesitancy** is difficulty or delay in initiating urine flow.
- **Post void Dribbling** and **incomplete** emptying are caused by bladder neck obstruction, but if they are associated with storage symptoms, may indicate abnormal detrusor function.
- **Poor stream**
  - In men over 40 this is commonly due **to bladder outlet obstruction** by prostatic enlargement.
  - In women these symptoms suggest urethral obstruction from stenosis or in association with genital prolapse.



## 9.2 Features of bladder outlet obstruction due to prostatic hyperplasia

- Slow flow
- Hesitancy
- Incomplete emptying (the need to pass urine again within a few minutes of micturition)
- Dribbling after micturition
- Frequency and nocturia (due to incomplete bladder emptying)
- A palpable bladder

# Incontinence (Involuntary loss of urine)

- **urge incontinence** : Involuntary Loss of urine preceded by urgency .
- **stress incontinence** : involuntary loss of urine result from an increase in intra-abdominal pressure such as effort or physical exertion (e.g sporting activities) or on sneezing or coughing”, occurs in women due to weakness of the pelvic floor, usually following childbirth.
- **mixed incontinence**: combination of both
- **Enuresis** is incontinence during sleep, and common in childhood. In adults it suggests bladder outlet obstruction or abnormalities of the waking mechanism.



## 9.6 Causes of urinary incontinence

- Pelvic floor weakness following childbirth
- Pelvic surgery or radiotherapy
- Detrusor overactivity
- Bladder outlet obstruction
- Urinary tract infection
- Degenerative brain diseases and stroke
- Neurological diseases, e.g. multiple sclerosis
- Spinal cord damage



## 9.11 Urinary incontinence: points to cover in the history

- Age at onset and frequency of wetting
- Occurrence during sleep (enuresis)
- Any other urinary symptoms
- Provocative factors, e.g. coughing, sneezing, exercising
- Past medical, obstetric and surgical histories
- Number of pads used. Are they damp, wet or soaked?
- Impact on daily living

# Abnormalities in urine volume and composition

- Healthy adults produce 2–3 litres of urine per day, equivalent to their fluid intake minus insensible fluid losses through the skin and respiratory tract (500– 800 ml/day).

# Polyuria

- Polyuria is an abnormally large volume of urine, and is most commonly due to excessive fluid intake.

**>3 L /day**

- psychogenic polydipsia
- Polyuria also occurs when the kidneys cannot concentrate urine:
  1. extrarenal, e.g. diuretic drugs; DM, DI, Addison's disease.
  2. Renal causes : nephrogenic diabetes insipidus

# Oliguria

- **<500 ml/day.** It may be appropriate with a very low fluid intake or mechanical obstruction , but may also indicate loss of kidney function.
- The minimum urine volume needed to excrete the daily solute load varies with diet, physical activity and metabolic rate, but is at least 500 ml/day.
- Acute renal failure is usually associated with oliguria .



# Anuria

- Anuria is the total absence of urine production. **< 50 per day**
- **Exclude urinary tract obstruction**, which may be lower (bladder neck or urethral obstruction causing acute urinary retention) or upper, e.g. a ureteric stone in a patient with a single functioning kidney.

# Pneumaturia

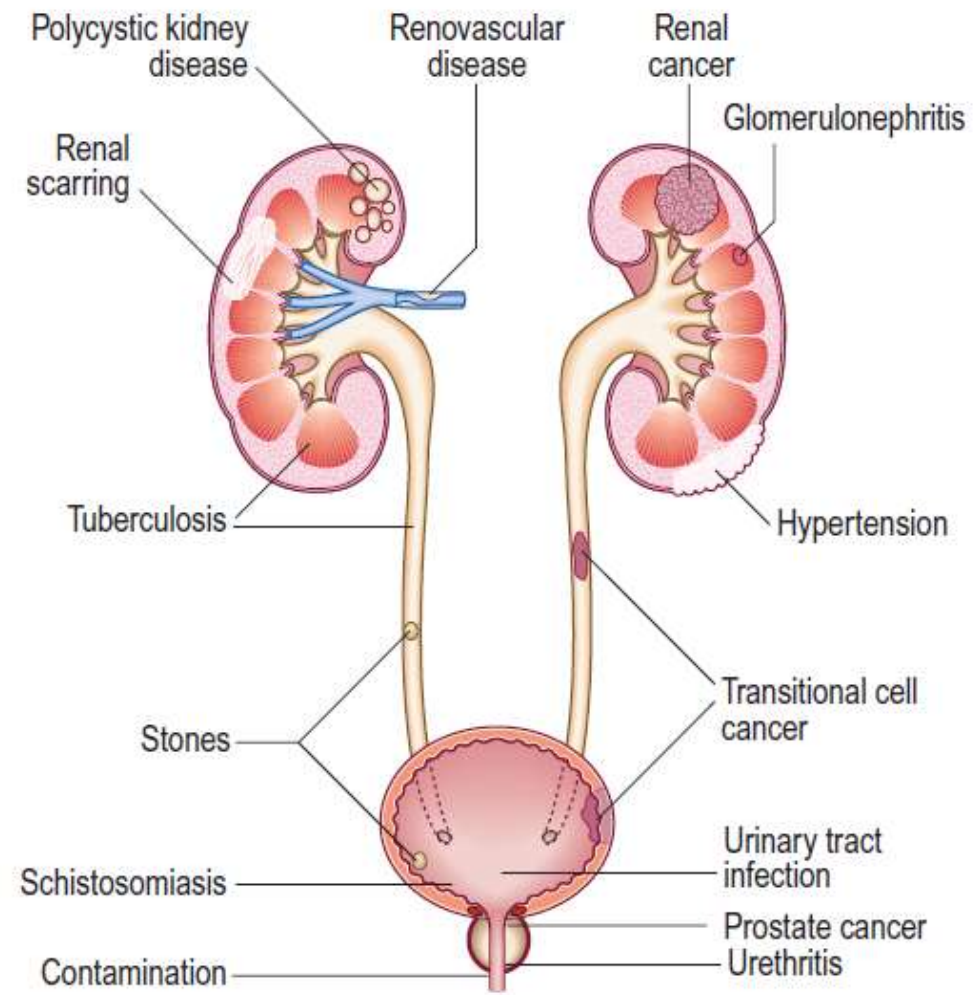
- passing gas bubbles in the urine, is rare.
- It may be associated with **faecuria**, when faeces are voided. It suggests a fistula between the bladder and the colon, from a diverticular abscess, cancer or Crohn's disease.

# Hematuria

- **Visible hematuria:**  
visible blood in the urine
- **Non-visible Hematuria:**  
it is a urine microscopic analysis diagnosis of more than or equal 3 RBC's/HPF
- **Non-visible hematuria is not diagnosed by Urine dipstick test!**

# Haematuria

- Non-visible haematuria occurs in renal diseases especially if associated with proteinuria, hypertension, raised serum creatinine or reduced estimated glomerular filtration rate.
- **Visible haematuria** may be due to urinary tract infection with its associated symptoms but should be investigated, if **painless** → cancer of the kidney, bladder or prostate.
- **Investigate all patients >40 years with haematuria** (visible or non-visible).
- contamination of the urine by blood from the female genital tract during **menstruation**.
- **Free haemoglobin** in the urine due to haemolysis, myoglobin in rhabdomyolysis and other abnormalities of urine colour may mimic haematuria
- Ask about : loin pain ,lower urinary symptoms, family hx





## 9.7 Abnormalities of urine colour

### Orange-brown

- Conjugated bilirubin
- Rhubarb, senna
- Concentrated normal urine, e.g. very low fluid intake
- Drugs: sulfasalazine

### Red-brown

- Blood, myoglobin, free haemoglobin, porphyrins
- Beetroot, blackberries
- Drugs: rifampicin, rifabutin, clofazimine, entacapone

### Brown-black

- Conjugated bilirubin
- Drugs: L-dopa, metronidazole, nitrofurantoin, chloroquine, primaquine
- Homogentisic acid (in alkaptonuria or ochronosis)

### Blue-green

- Drugs/dyes, e.g. propofol, fluorescein, triamterene



# Proteinuria

- Proteinuria is excess protein in urine and indicates kidney disease.
- It is usually asymptomatic and detected by urinalysis
- most commonly glomerulonephritis or diabetic nephropathy.
- **>3.5 g/ day in adults or 1g/ m<sup>2</sup>/day in children → nephrotic syndrome**
- **More than 150 mg/day (Except children and pregnancy; 300 mg/d)**
- Proteinuria may occur in normal patients with febrile illness. Orthostatic proteinuria is proteinuria <1 g/l which disappears when lying down
- Severe proteinuria may produce frothy urine. May reduce the plasma oncotic pressure, the patient develops generalised oedema
- Ask about : wt loss , ankle swelling , SOB , abdominal swelling





## 9.9 Causes of proteinuria

### Renal disease

- Glomerulonephritis
- Diabetes mellitus
- Amyloidosis
- Systemic lupus erythematosus
- Drugs, e.g. gold, penicillamine
- Malignancy, e.g. myeloma
- Infection

### Non-renal disease

- Fever
- Severe exertion
- Severe hypertension
- Burns
- Heart failure
- Orthostatic proteinuria\*

\*Occurs when a patient is upright but not lying down; the first morning sample will not show proteinuria.



## 9.10 Causes of transient proteinuria

- Cold exposure
- Vigorous exercise
- Febrile illness
- Abdominal surgery
- Heart failure

# ACUTE KIDNEY INJURY

- Abrupt elevation in serum cr conc. Or a decrease in urine output
- It may have prerenal , renal and postrenal causes
- PRERENAL
- RENAL
- POSTRENAL

## 12.2 Causes of acute kidney injury

### Prerenal

- Hypovolaemia (e.g. blood loss, diarrhoea, vomiting, diuresis, inadequate oral intake)
- Relative hypovolaemia (e.g. heart failure, nephrotic syndrome)
- Sepsis
- Drugs (e.g. antihypertensives, diuretics, non-steroidal anti-inflammatory drugs)
- Renal artery stenosis or occlusion
- Hepatorenal syndrome

### Intrarenal

- Glomerular disease (e.g. systemic vasculitis, systemic lupus erythematosus, immunoglobulin A nephropathy)
- Interstitial nephritis (drug-induced)
- Acute tubular necrosis/injury (may follow a prerenal cause)
- Multiple myeloma
- Rhabdomyolysis
- Intrarenal crystal deposition (e.g. urate nephropathy, ethylene glycol poisoning)
- Thrombotic microangiopathy (e.g. haemolytic uraemic syndrome, scleroderma renal crisis)
- Accelerated-phase hypertension
- Cholesterol emboli

### Postrenal

- Renal stones (in papilla, ureter or bladder)
- Papillary necrosis
- Ureteric or bladder transitional cell carcinoma
- Intra-abdominal or pelvic malignancy (e.g. cervical carcinoma)
- Retroperitoneal fibrosis
- Blood clot
- Bladder outflow obstruction (e.g. prostatic enlargement)
- Neurogenic bladder
- Urethral stricture
- Posterior urethral valves
- Iatrogenic (e.g. ureteric damage at surgery, blocked urethral catheter)

A less common cause of AKI is a history of fall (ATI) normal can also be the that affects the vasculitis or s

Ask about:

- Recent illness
  - Drug history
- Several common antibiotics recognise almost all
- Symptoms: night sweats, joint pain, numbness, breathless

Occasionally glomerulonephritis cause in the presents with tract infection

Ask about:

- prior episodes
- loin pain
- previous infections in post-beta-hemolytic or skin

### Postrenal

This is usually the pelvis to obstruct either be

Ask about:

- urinary symptoms
- poor

# CHRONIC KIDNEY DISEASE

- Alteration in kidney function or structure for more than 3 months
- Look for underlying conditions that may explain the etiology of CKD:
- HTN , DM , VASCULAR D. ( MI /PAD /STROKE) , HYPERLIPIDEMIA , EPISODES OF ACUTE GN , NEPHROTIC SYNDROME
- PROTEINUREA OR HAEMATUREA MAY SUGGEST A GLOMERULAR D,
- DETAILED FHX IS REQUIRED AS A NUMBER OF GENETIC DISEASES MAY PRESENT WITH CKD

# END STAGE RENAL DISEASE AND URAEMIA

- Most commonly when the estimated GFR less than 10ml/min/1.73m<sup>2</sup>
- Poor conc , lethargy, anorexia ,n ,v pruritus , sob, peripheral edema
- Less commonly pericarditis and peripheral neuropathy

# DIALYSIS PATIENTS

- HAEMODIALYSIS : via arteriovenous fistula
  - The fistula has an obvious thrill
  - The most common problem here is infection
- 
- PERITONEAL DIALYSIS :via a tunnelled catheter
  - Infection is also common here

# Past history

Ask about any previous history of renal system disease.

- **hypertension** (which may cause or result from renal disease)
- **diabetes mellitus** (associated with diabetic nephropathy and renovascular disease)
- vascular disease at other sites (which makes renovascular disease more likely)
- past history of urinary tract **stones** or surgery
- renal disease
- **recurrent infections** (particularly urinary infection which may be associated with renal scarring, and upper respiratory infections which may be associated with glomerulonephritis and/or vasculitis)
- **anaemia** (which may be due to CKD).

# Drug history

- **Drugs which accumulate in renal failure**, such as digoxin, lithium, aminoglycosides, opioids and water soluble beta-blockers, e.g. atenolol.
- **Drugs which may affect renal function** include angiotensin-converting enzyme inhibitors, angiotensin receptor antagonists and NSAIDs.
- Aminoglycosides, amphotericin, lithium, ciclosporin, tacrolimus and, in overdose, paracetamol are **toxic to normal kidneys**.



# Family history

- The most common inherited conditions are **APKD (autosomal dominant)** and **Alport's syndrome (X-linked)** .
- APKD is associated with subarachnoid haemorrhage from intracranial berry aneurysms;
- Alport's syndrome is associated with high-tone sensorineural deafness.



## 9.12 Some hereditary and congenital conditions affecting the kidneys and urinary tract

Name	Principal findings	Commonly associated abnormalities	Most common form of inheritance
<b>Adult polycystic kidney disease</b>	Bilateral enlarged kidneys, sometimes massive, with nodular surface	Liver cysts Intracranial berry aneurysms Mitral or aortic valve abnormalities	Autosomal dominant
<b>Alport's syndrome</b>	Haematuria, proteinuria, renal failure	Nerve deafness Lens and retinal abnormalities	X-linked dominant
<b>Medullary sponge kidney</b>	Tubular dilatation; renal stones	Other congenital abnormalities, e.g. hemihypertrophy, cardiac valve abnormalities, Marfan's syndrome	Congenital, rarely familial
<b>Nail-patella syndrome</b>	Proteinuria Renal failure (30%)	Nail dysplasia, patellar dysplasia or aplasia	Autosomal dominant
<b>Cystinosis</b>	Tubular dysfunction; renal failure	Rickets, growth retardation, retinal depigmentation and visual impairment	Autosomal recessive
<b>Tuberous sclerosis complex</b>	Renal cysts Renal angioliomata	Seizures, mental retardation, facial angiofibromata, retinal lesions	Autosomal dominant
<b>Prune-belly syndrome</b>	Dilated bladder and urinary tract; urinary infection and renal failure	Absent abdominal wall musculature	Sporadic mutation

# Social history

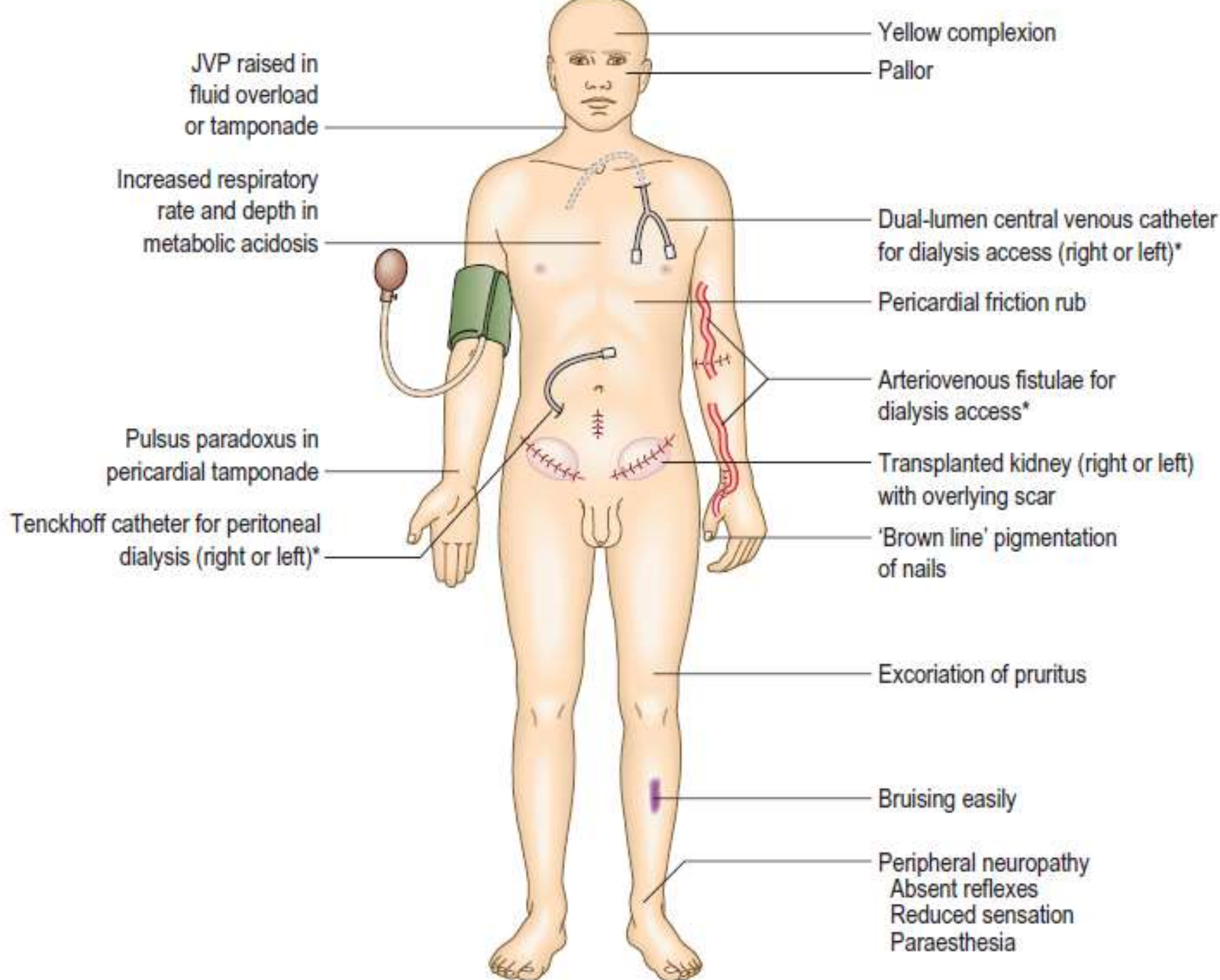
- **End-stage renal disease** requiring dialysis and/or transplantation has major implications for lifestyle, employment and relationships.  
Similarly
- **incontinence** has major implications for daily living.
- **Smoking.**
- Take a dietary history in patients with renal stones and patients with CKD.

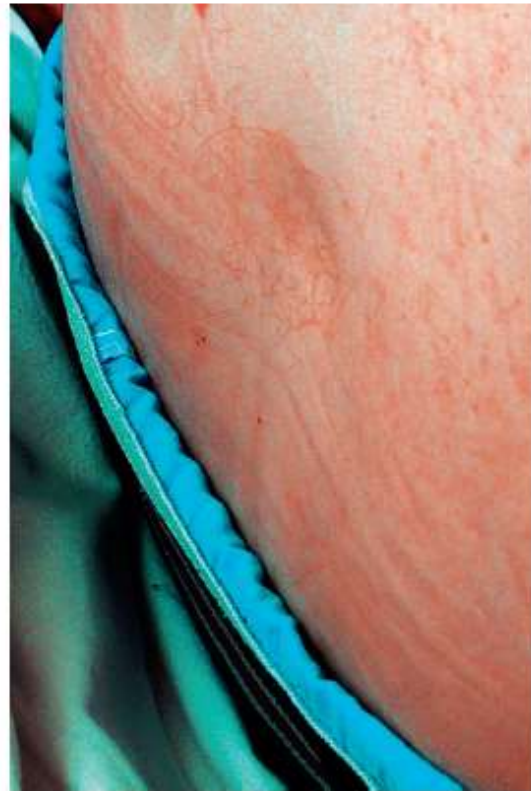
# Occupational history

- Exposure to organic solvents may cause glomerulonephritis.
- **Aniline dye** and **rubber** workers have an increased incidence of urothelial cancer.
- Long term exposure to lead and cadmium may cause renal damage.

# THE PHYSICAL EXAMINATION

- Physical examination may be normal, even with significant kidney disease





Sacral oedema showing pitting.

# Examination sequence

Assess the patient's **general appearance** and conscious level.

- Look for **fatigue, pallor, breathlessness, uraemic** complexion, **cushingoid** appearance and hirsutism.
- Measure the **temperature** + vs ( bp( + postural ) , hr
- Look at the eyes for anaemia.fundoscopy
- Note any bruising or excoriation.
- Examine the hands for nail changes, vasculitic rash
- Look for a coarse **flapping tremor**
- Smell the patient's breath for **uraemic fetor**.
- Assess **hydration** by checking skin turgor, eyeball tone, JVP and presence of oedema , dry mucus membrane , weight assessment , fluid balance chart



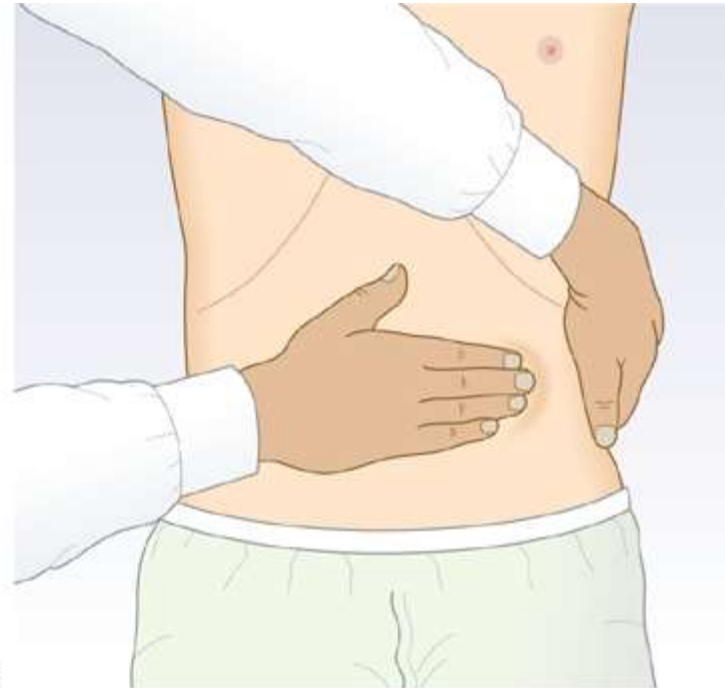
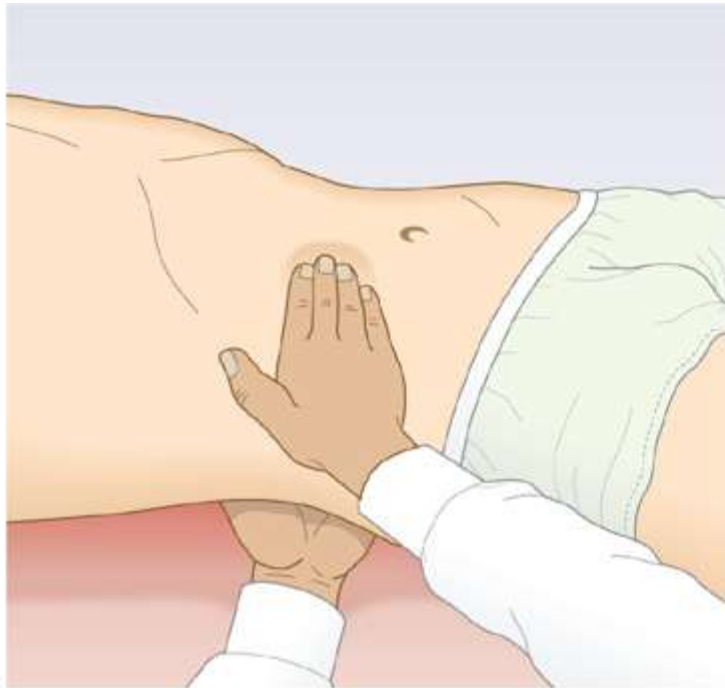
# Abdominal examination

## Inspection

- Look for **distension** (from the enlarged kidneys of APKD, ascites, and suprapubically from bladder distension).
- Look in the loins for **scars** of renal tract surgery and in the iliac fossa for those of transplant surgery.
- You may see a catheter for peritoneal dialysis or small scars left by one in the midline and hypochondrium.

# Palpation

- palpate the kidneys.
- If the kidney is palpable, assess its size, surface and consistency.
- Ask the patient to sit up. Palpate the renal angle



A

B

- Use the fingers of your right hand. Start in the right lower quadrant and palpate each area systematically. A distended bladder is felt as a smooth firm mass arising from the pelvis which disappears after urethral catheterization. Polycystic kidneys have a distinctive nodular surface.

- To detect lesser degrees of kidney enlargement, place your left hand behind the patient's back below the lower ribs and your right index finger against the 12<sup>th</sup> rib . Firmly, but gently, push your hands together as the patient breathes out. Ask the patient to breathe in deeply; feel for the lower pole of the kidney moving down between your hands. If this happens, gently push the kidney back and forwards between your two hands to demonstrate its mobility. This is ballotting, and confirms that this structure is the kidney.

- Ask the patient to sit up. Palpate the renal angle firmly but gently. If this does not cause the patient discomfort, firmly (but with moderate force only!) strike the renal angle once with the ulnar aspect of your closed fist after warning the patient what to expect

# Percussion

Percussion of the kidneys is unhelpful.

Enlarged kidney >> resonant

- **Percuss for the bladder** over a resonant area in the upper abdomen in the midline and then down towards the symphysis pubis.
- Test for **ascites**, which may be found in nephrotic syndrome or in patients having peritoneal dialysis.

# Auscultation and...

- Auscultate for bruits arising from the **renal arteries**.
- Test for **ascites**, which may be found in nephrotic syndrome or in patients having peritoneal dialysis.
- In men examine the external genitalia and perform a **rectal examination to assess the prostate for benign or malignant change**.

# Cardiovascular examination

## Examination sequence

- Measure the pulse and blood pressure
- Assess the JVP
- Palpate the apex beat.
  - Auscultate for:
    - Quiet heart sound
    - a mid-systolic 'flow' murmur
    - third or fourth heart sounds ((fourth heart sound if the left ventricle is affected by Hypertension)
    - pericardial friction rub.
  - Look for pitting oedema in the ankles, the sacrum, and the back of the thighs in recumbent patients

# Respiratory examination

Measure the respiratory rate

- Percuss the chest to detect **pleural effusions**.
- Auscultate for **bilateral basal lung crackles** indicating fluid overload or heart failure.

# Nervous system

Assess level of **consciousness** .

- **Test sensation and the tendon reflexes** .
- Examine the optic fundi .
- Peripheral neuropathy ( dm )



#### Face and neck 4

- Yellow complexion\*
- Pallor
- JVP
- Uraemic foetor\*
- Gingival hyperplasia

#### 5 Eyes

- Hypertensive retinopathy
- Diabetic retinopathy
- Band keratopathy

#### 6 Lung bases

- Crackles in fluid overload
- Hyperventilation (acidaemia)

#### 7 Heart

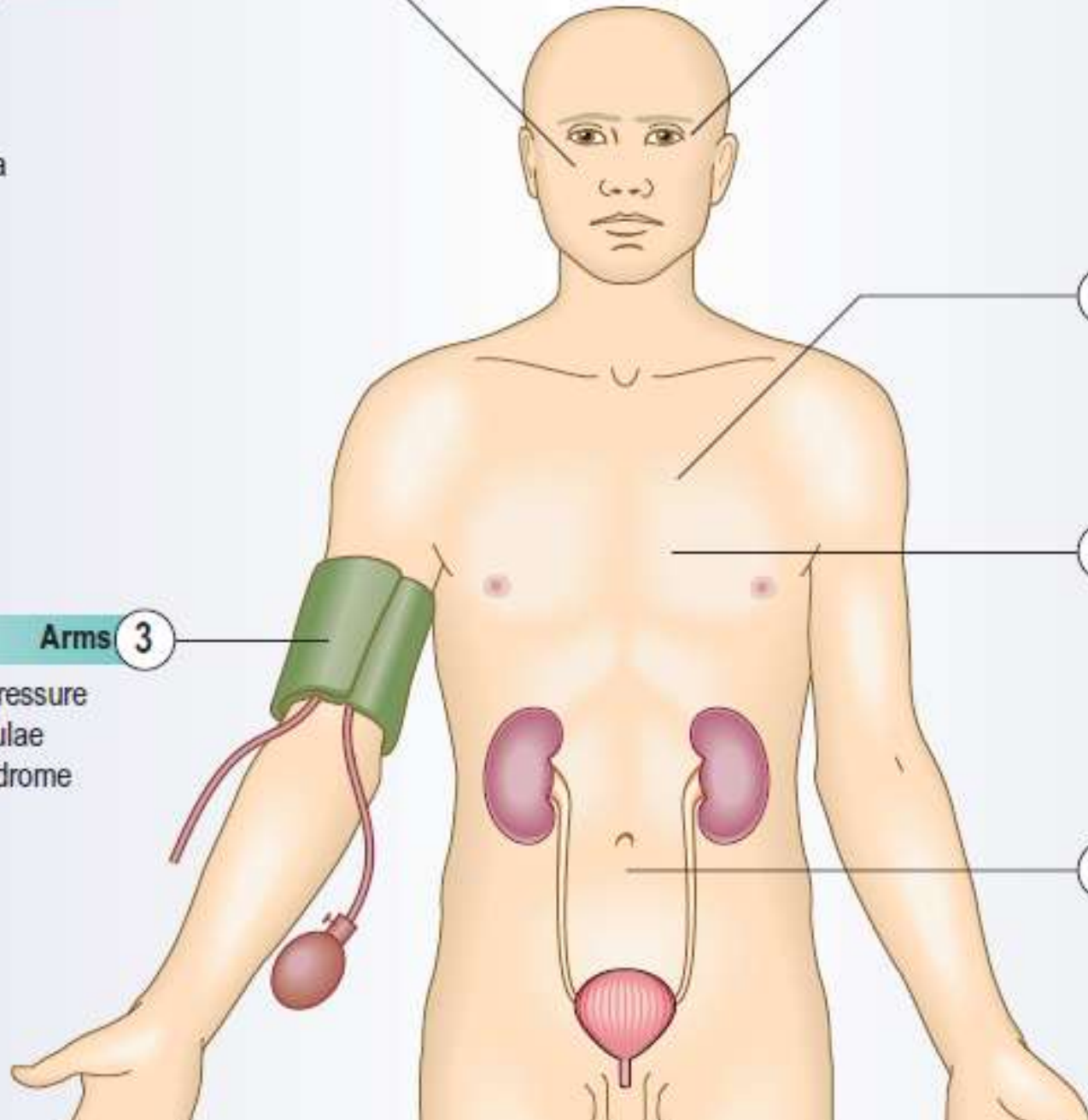
- Extra heart sounds
- Pericardial friction rub\*

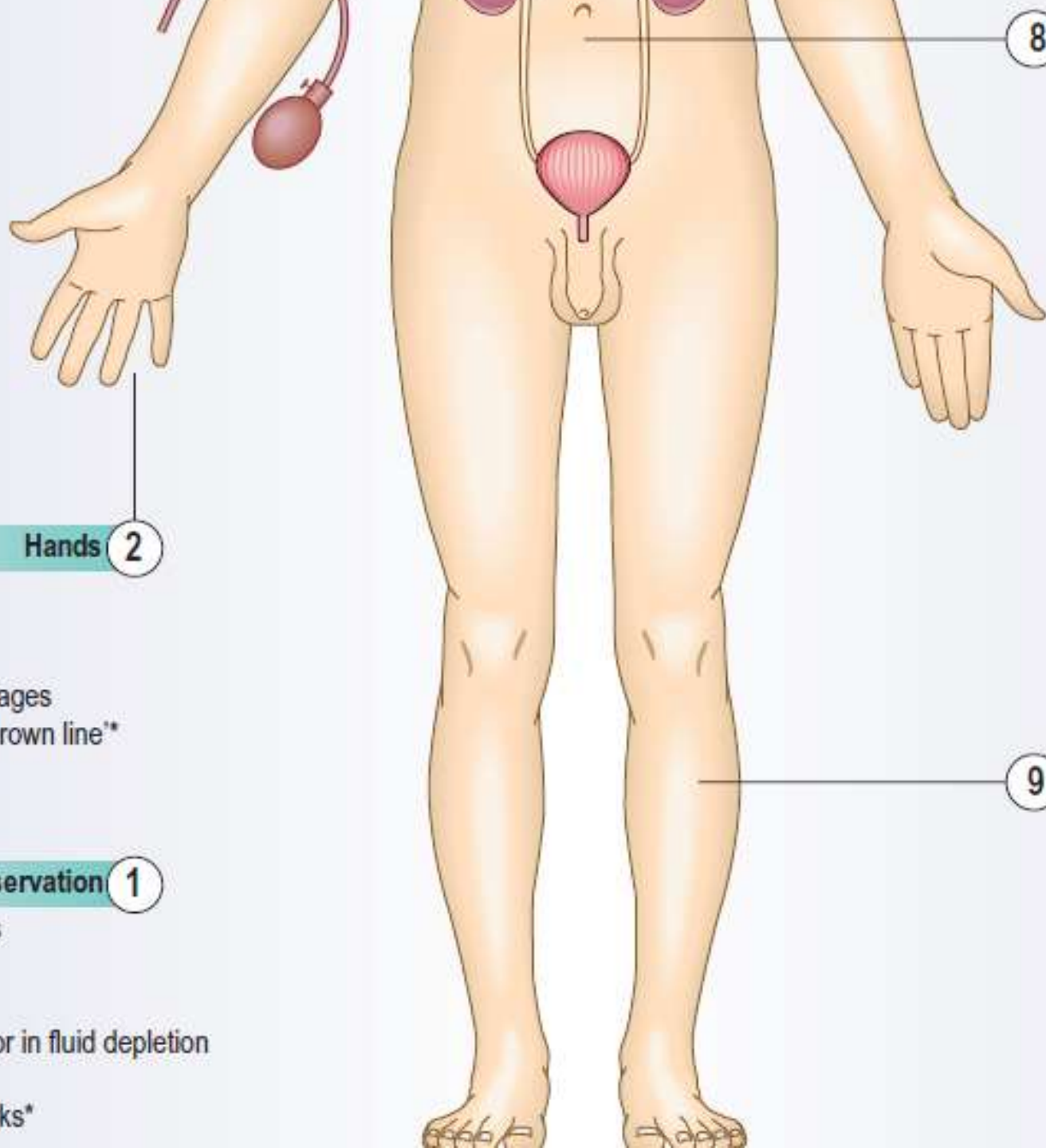
#### Arms 3

- Pulse and blood pressure
- Arteriovenous fistulae
- Carpal tunnel syndrome

#### 8 Abdomen

- Inspect scars
- Palpate kidneys bladder sacral oedema





## 8 Abdomen

- Inspect scars
- Palpate kidneys bladder sacral oedema
- Auscultate renal arterial bruits
- Rectal examination prostate enlargement

## Hands 2

- Asterixis
- Nail features
  - Beau's lines
  - splinter haemorrhages
  - pigmentation – 'brown line'
  - Muehrcke's lines

## General observation 1

- Pallor and tiredness
- Breathlessness
- Hydration
  - reduced skin turgor in fluid depletion
- Bruising\*
- Itching, scratch marks\*

## 9 Legs

- Oedema
  - hypoproteinaemia
  - fluid overload
- Peripheral neuropathy\*