

High-Yield Notes & Traps

Every high-yield fact and every common exam trap, subtopic by subtopic, across the whole RCEM Basic Sciences curriculum.

Anatomy · Physiology · Pharmacology
Microbiology · Pathology · Evidence-Based Medicine

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How to use this guide

This is not a textbook. It is the fast-revision layer: every high-yield fact that MRCEM Primary MCQs are built on, and the tempting wrong options that turn a known fact into a lost mark. Nothing examinable has been cut for length: if it can be asked as an MCQ and it was high-yield or a trap in the MrcemUltra theory notes, it is here.

Every chapter follows the RCEM Basic Sciences curriculum in order: subject, then topic, then subtopic. The content comes from the MrcemUltra theory notes, which are written against the same syllabus map as our MCQ bank. The layout is single-column so it reads as well on a phone as on paper.

Reading each page

Navy band	A curriculum topic. Each starts with its place in the chapter.
Amber-ruled heading	A section within the topic; amber-barred headings below it are the subtopics.
Fact table	Every high-yield point for the subtopic, in exam wording. Read the bold left column as the question stem, the right as the answer.
Amber box	Exam traps, written the way MCQs set them: × the tempting wrong option, then ✓ the correct answer and why.

A seven-day plan for the final week

Day 1	Anatomy I	Upper limb, lower limb, thorax.
Day 2	Anatomy II	Abdomen, head and neck, CNS, cranial nerve lesions.
Day 3	Physiology	All six topics. Focus on direction-of-change questions.
Day 4	Pharmacology	Doses, antidotes, contraindications, interactions.
Day 5	Microbiology + Pathology	Organism-toxin-test-treatment links; haematology distinctions.
Day 6	EBM + full mock	Statistics and study design, then a timed mock exam.
Day 7	Traps only	Re-read every amber box in the guide (about 1,700 traps: cover the ✓ lines and say why each × option is wrong). Then stop: an early night beats one more chapter.

A note on accuracy

Drug doses and management points reflect UK practice at the time of writing. Always check current BNF and national guidance in clinical practice. This guide is an independent revision resource and is not affiliated with or endorsed by the Royal College of Emergency Medicine.

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CHAPTER 1

Anatomy

7 curriculum topics · 257 subtopics · 450 exam traps

Upper Limb · Lower Limb · Thorax · Abdomen · Head & Neck · Central Nervous System · Cranial Nerve Lesions

ANATOMY · TOPIC 1 OF 7

Upper Limb

Pectoral Region

Pectoral Joints

Joint	Role in pectoral movement	Main stability principle	High-yield applied point
Sternoclavicular	Positions the clavicle relative to the sternum; permits elevation, depression, protraction, retraction and rotation	Ligament-dependent stability rather than bony interlock	Essential medial link allowing the pectoral girdle to move freely
Acromioclavicular	Allows fine scapular adjustment relative to the clavicle during shoulder girdle movement	Ligament-dependent stability, particularly via AC and coracoclavicular ligaments	Transmits force across the lateral pectoral girdle after a fall on the outstretched hand

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The shoulder girdle moves as a rigid frame needing no joint movement
- ✓ Normal upper limb positioning needs movement at both sternoclavicular and acromioclavicular joints
- ✗ Sternoclavicular and acromioclavicular joints are stable because of bony interlock
- ✓ Stability is primarily ligamentous (e.g. coracoclavicular ligaments laterally), not from bony shape

Pectoral Muscles

Muscle	Surface cue	Principal actions	Nerve supply
Pectoralis major	Anterior chest wall; anterior axillary fold	Arm adduction and medial rotation; assists flexion and return from flexion	Lateral and medial pectoral nerves
Pectoralis minor	Deep to pectoralis major; projected towards coracoid process	Draws scapula anteriorly and inferiorly; stabilises it against thoracic wall; may assist deep inspiration	Medial pectoral nerve
Trapezius	Posterior neck and upper back; neck–shoulder contour	Scapular elevation, retraction, depression and upward rotation	Spinal accessory nerve; C3–C4 proprioceptive/sensory fibres
Latissimus dorsi	Lower posterior trunk; posterior axillary fold	Arm extension, adduction and medial rotation; assists trunk elevation when arms are fixed	Thoracodorsal nerve
Serratus anterior	Lateral thoracic wall; digitations along ribs	Scapular protraction, fixation to thoracic wall and upward rotation	Long thoracic nerve

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The anterior axillary fold is formed by latissimus dorsi
- ✓ Pectoralis major forms the anterior axillary fold; latissimus dorsi forms the posterior fold
- ✗ Trapezius motor supply comes from a brachial plexus nerve
- ✓ Spinal accessory nerve (CN XI); C3–C4 carry only proprioceptive/sensory fibres
- ✗ Serratus anterior retracts the scapula
- ✓ Serratus anterior protracts, upwardly rotates and fixes the scapula to the thoracic wall (long thoracic nerve)
- ✗ Clavicular and sternocostal fibres of pectoralis major act identically
- ✓ The two parts contribute differently: arm flexion versus return from flexion, both adducting and medially rotating
- ✗ Pectoralis minor only draws the scapula anteriorly and inferiorly
- ✓ It also stabilises the scapula against the thoracic wall (and may assist deep inspiration)
- ✗ Pectoralis major is supplied by the lateral pectoral nerve alone
- ✓ Pectoralis major: medial and lateral pectoral nerves; pectoralis minor: medial pectoral nerve
- ✗ Serratus anterior and trapezius act mainly on the humerus
- ✓ Latissimus dorsi acts on the humerus; serratus anterior and trapezius are primarily scapular movers

Axilla

Axillary Contents

Transmission role of axilla	The axilla conveys the neurovascular bundle from the neck to the upper limb.
Axillary artery	Acts as the key arterial conduit in the region and is the source of the circumflex humeral arterial supply.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The axilla is merely an empty recess under the shoulder
- ✓ It is a neurovascular corridor conveying the axillary vessels and brachial plexus from neck to upper limb

Axillary Muscles

Muscle	Surface cue	Principal actions	Nerve supply
Subscapularis	Deep posterior wall of axilla; against anterior surface of scapula	Medial rotation of arm; assists adduction	Upper and lower subscapular nerves
Teres major	Inferior scapular region; lower posterior axillary fold	Extension, adduction and medial rotation of arm	Lower subscapular nerve

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Teres major and teres minor share the same action and nerve supply
- ✓ Teres major: lower subscapular nerve, medial rotation/adduction; teres minor: axillary nerve, lateral rotation
- ✗ Subscapularis produces an obvious superficial contour
- ✓ Subscapularis is deep, on the anterior scapula forming the posterior axillary wall; no obvious surface contour

Brachial Plexus

Roots	Anterior rami from C5–T1 contribute to the plexus.
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Trunks	Roots unite to form upper, middle and lower trunks.
Divisions	Each trunk separates into anterior and posterior divisions.
Cords	Divisions regroup into cords within the axillary region before continuing towards the limb.

Breast

Chest Drain Landmarks

- The principal landmark area for chest drain insertion is the safe triangle on the lateral chest wall.
- Its boundaries are the lateral border of pectoralis major, the anterior border of latissimus dorsi, the base of the axilla, and the level of the 5th intercostal space.
- These landmarks are important because they keep insertion on the lateral thoracic wall and away from the main breast tissue and axillary neurovascular contents.
- Intercostal access must respect rib anatomy, with entry just above the upper border of the rib.

Lymph Drainage of the Breast

- Most lymph from the breast drains to the axillary nodes.
- Lateral quadrants drain mainly to axillary nodes; medial quadrants drain more often to parasternal nodes.
- A small amount of lymph may drain posteriorly to posterior intercostal nodes.
- Medial drainage may cross the midline and involve contralateral nodes.

Shoulder

Shoulder Joint

- The glenohumeral joint is a synovial ball-and-socket joint.
- Its stability depends more on soft tissues than on bony congruity.
- Supporting ligaments include the glenohumeral ligaments, coracohumeral ligament and transverse humeral ligament.
- The coraco-acromial arch is formed by the coracoid process, acromion and coraco-acromial ligament.
- The rotator cuff muscles and tendons are major dynamic stabilisers of the joint.

Shoulder Muscles and Movements

Supraspinatus	Initiates abduction; supplied by suprascapular nerve (C5, C6).
Infraspinatus	Lateral rotator of the arm; supplied by suprascapular nerve (C5, C6).
Teres minor	Lateral rotator; supplied by axillary nerve (C5, C6).
Deltoid	Main abductor after initiation; supplied by axillary nerve (C5, C6).
Full elevation of the limb	Requires both humeral movement and upward rotation of the scapula.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Deltoid initiates shoulder abduction
- ✓ Supraspinatus initiates abduction; deltoid is the main abductor thereafter
- ✗ Full shoulder elevation occurs at the glenohumeral joint alone
- ✓ Full elevation also requires upward rotation of the scapula
- ✗ Infraspinatus and teres minor are both supplied by the axillary nerve
- ✓ Supraspinatus and infraspinatus: suprascapular nerve; deltoid and teres minor: axillary nerve (all C5, C6)

Anterior Arm

Anterior Arm Muscles

Compartment function	Flexor compartment of the arm
Main motor nerve	Musculocutaneous nerve
Strongest supinator	Biceps brachii
Primary elbow flexor	Brachialis
Brachial pulse at elbow	Palpated medial to the biceps tendon

Brachial Artery

Origin	Continuation of the axillary artery at the lower border of teres major
Course	Runs along the anterior and medial aspect of the arm toward the cubital fossa
Palpation landmark	Immediately medial to the biceps tendon at the elbow
Principal branches	Profunda brachii, muscular branches, nutrient branch, ulnar collateral arteries
Termination	Division into radial and ulnar arteries in the cubital fossa
Associated veins	Paired venae comitantes accompany the artery

Median Nerve

- The median nerve is formed by a lateral root and a medial root from the brachial plexus.
- In the arm it travels with the brachial artery.
- It lies lateral to the artery proximally, crosses anterior to it around mid-arm, and lies medial to it distally.

Musculocutaneous Nerve

- The musculocutaneous nerve supplies coracobrachialis, biceps brachii and brachialis in the anterior arm.
- It is the nerve of the flexor compartment of the arm.
- Its most important functional association is with elbow flexion.
- Damage to the nerve weakens the main anterior arm flexors.

Other Cutaneous Nerves of the Anterior Arm

- The medial cutaneous nerve of arm supplies skin on the medial side of the arm.
- The medial cutaneous nerve of forearm supplies skin on the medial side of the forearm.
- The intercostobrachial nerve supplies the axilla and upper medial arm.

Supratrochlear and Infraclavicular Lymph Nodes

- Supratrochlear nodes are located above the medial epicondyle near the basilic vein.
- They receive lymph mainly from the medial side of the hand and forearm.
- Infraclavicular nodes lie in the deltopectoral groove below the clavicle alongside the cephalic vein. They receive lymph from superficial lymphatics accompanying the cephalic vein on the lateral side of the upper limb.

Ulnar Nerve

- In the anterior arm, the ulnar nerve descends on the medial side of the arm.
- It lies medial to the main vessels in the arm.
- In the lower arm it passes posteriorly through the medial intermuscular septum.
- At the elbow it passes behind the medial epicondyle.

Posterior Arm

Elbow Joint

Joint type	A hinge synovial joint complex.
Bony articulations	Humeroulnar, humeroradial and proximal radioulnar.
Medial collateral ligament	Medial stabiliser, described as anterior, posterior and transverse bands.
Lateral collateral ligament	Lateral stabiliser, forming a banded complex on the lateral side.
Annular ligament	Retains the radial head and allows rotation in pronation and supination.
Main movements	Flexion, extension, pronation and supination.
Clinical relevance	A pathological increase in carrying angle may predispose to ulnar nerve palsy.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The elbow is a simple hinge between humerus and ulna only
- ✓ Elbow complex includes the proximal radioulnar articulation, allowing pronation and supination
- ✗ The annular ligament plays no role in radial head rotation
- ✓ The annular ligament retains the radial head and allows its rotation in pronation and supination
- ✗ Cubitus valgus has no link with ulnar nerve palsy
- ✓ Increased carrying angle (cubitus valgus) may stretch the ulnar nerve behind the medial epicondyle, causing palsy

Posterior Arm Muscles

Main posterior arm muscle	Triceps brachii
Primary action	Extension of the elbow
Additional action	Long head assists shoulder extension and adduction
Innervation	Radial nerve
Clinical test	Elbow extension against resistance
Clinical importance	Weakness suggests posterior arm injury or radial nerve dysfunction

Radial Nerve

Key relation	Radial nerve runs in the spiral groove on the posterior humerus
Clinical significance	Mid-shaft humeral fractures may injure the nerve

Surface marking	Posterior arm to lateral elbow as the nerve winds around the humerus
Motor role	Supplies triceps brachii
Exam principle	Level of lesion determines whether triceps is affected

Anterior Forearm

Nerves of the Anterior Forearm (Flexor Compartment)

Lateral cutaneous nerve of forearm	Cutaneous supply to the lateral forearm.
Medial cutaneous nerve of forearm	Cutaneous supply to the medial forearm.
Median nerve	Main nerve of the anterior forearm; supplies most flexor muscles and gives the anterior interosseous nerve.
Ulnar nerve	Supplies flexor carpi ulnaris and medial half of flexor digitorum profundus.
Median nerve lesion	Level matters: proximal lesions cause major motor loss in forearm and hand; distal lesions mainly affect thenar function and sensation.

Anterior Forearm Muscles

Common origin	Superficial flexor-pronator muscles arise from the medial humeral epicondyle.
Main nerve supply	Predominantly median nerve; deep supply often via the anterior interosseous branch.
Ulnar-nerve exceptions	Flexor carpi ulnaris and the medial part of flexor digitorum profundus.
Main functions	Pronation plus flexion at the wrist, fingers and thumb.

Arteries of the Anterior Forearm

- The brachial artery divides into the radial and ulnar arteries in the cubital fossa, at the level of the neck of the radius.
- The radial artery is the lateral terminal branch and is palpable at the wrist on the thumb side.
- The ulnar artery is the medial terminal branch and gives off the common interosseous artery.
- Radial and ulnar contributions form anterior and posterior carpal arches at the wrist.
- These arterial connections provide collateral flow around the wrist and into the hand.

Radioulnar Joints

- The proximal and distal radioulnar joints act together.
- They allow pronation and supination of the forearm.
- Pronation is produced by pronator teres and pronator quadratus; supination by supinator and biceps brachii.
- Flexion and extension are produced mainly at the elbow joint.

Veins of the Anterior Forearm

- The deep veins of the anterior forearm are venae comitantes that accompany the main arteries.
- The cephalic vein lies laterally in the forearm.
- The basilic vein lies medially in the forearm.
- The median forearm vein ascends in the front of the forearm, often near the midline.

Posterior Forearm

Anatomical Snuffbox

- The anatomical snuffbox is a triangular depression on the dorsolateral wrist that becomes prominent on thumb extension.
- Its lateral boundary is formed by abductor pollicis longus and extensor pollicis brevis; its medial boundary is formed by extensor pollicis longus.
- The scaphoid, trapezium and base of the first metacarpal are palpable in relation to this region.
- Snuffbox tenderness after a fall onto the outstretched hand is classically associated with scaphoid fracture.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Extensor pollicis longus forms the lateral boundary of the anatomical snuffbox
- ✓ Lateral: abductor pollicis longus and extensor pollicis brevis; medial: extensor pollicis longus alone

Extensor Retinaculum

- The extensor retinaculum is a fascial band on the dorsum of the distal forearm and wrist.
- It attaches laterally to the radius and medially to the ulnar side of the wrist, including the pisiform and triquetrum.
- The long extensor tendons pass deep to it in six compartments.
- Its main function is to hold extensor tendons close to bone and prevent bowstringing.

Posterior Compartment Muscles

Main compartment function	Wrist, finger and thumb extension, plus supination.
Main nerve supply	Radial nerve, deep branch of radial nerve, and posterior interosseous nerve.
Brachioradialis	Elbow flexor in the mid-prone position; radial nerve.
Supinator	Supinates the forearm; deep branch of radial nerve.
Posterior interosseous nerve lesion	Marked weakness of finger and thumb extension with relative preservation of some wrist extension.

Wrist and Hand

Carpal Tunnel

Flexor digitorum superficialis	Four tendons in the tunnel, separated from one another.
Flexor digitorum profundus	Four tendons in the tunnel, grouped together.
Flexor pollicis longus	Single tendon to the thumb within the tunnel.
Median nerve	Lies within the tunnel, superficial and on the radial side.

Digital Nerves

Median digital territory	Thumb, index, middle, and radial half of ring finger
Ulnar digital territory	Little finger and ulnar half of ring finger
Recurrent median branch	Motor branch to thenar muscles; key for thumb opposition and abduction
Common palmar digital nerves	Run towards web spaces before dividing
Proper digital nerves	Paired radial and ulnar nerves along each digit

Injury pattern	One-sided digit sensory loss suggests proper digital nerve damage; adjacent-sided loss across two digits suggests common digital nerve damage
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Flexor Retinaculum

- The flexor retinaculum spans the anterior carpus and forms the roof of the carpal tunnel.
- It attaches laterally to the scaphoid tubercle and trapezium, and medially to the pisiform and hook of hamate.
- Thenar and hypothenar muscles take origin from it.
- The ulnar nerve and artery, palmaris longus tendon, and palmar cutaneous branch of the median nerve pass superficial to it.
- The median nerve, flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus pass deep to it through the carpal tunnel.

Flexor Sheaths

Thumb flexor sheath	Contains flexor pollicis longus.
Digital flexor sheaths of digits 2–5	Contain flexor digitorum superficialis and flexor digitorum profundus.
Thenar space	Radial deep palmar space that may become involved in sheath-related spread.
Midpalmar space	Central deep palmar space that may become involved in spread from the flexor sheath system.
Lumbrical canals	Potential channels for extension between the deep palm and interdigital regions.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Digital flexor sheath infection always stays confined to that digit
- ✓ Infection can spread from the sheath into the deep palm via lumbrical canals, thenar or midpalmar spaces
- × Lumbrical canals have no role in spread of hand infection
- ✓ Lumbrical canals are potential routes between interdigital regions and the deep palm
- × Thenar and midpalmar spaces are clinically incidental spaces
- ✓ They are clinically important destinations for spread of flexor sheath infection

Hypothenar Eminence

- The hypothenar eminence contains abductor digiti minimi, flexor digiti minimi, and opponens digiti minimi.
- Abductor digiti minimi abducts the little finger.
- Flexor digiti minimi flexes the little finger.
- Opponens digiti minimi produces opposition of the little finger by acting on the 5th metacarpal.
- All three are supplied by the deep branch of the ulnar nerve.

Lumbricals and Interossei

Lumbricals	Four muscles derived from FDP tendons; attach to extensor expansions
Lumbrical innervation	Lateral two median; medial two ulnar
Lumbrical action	MCP flexion with IP extension
Palmar interossei	Three; adduct digits; ulnar nerve
Dorsal interossei	Four; abduct digits; ulnar nerve

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Palmar interossei abduct the fingers
- ✓ Palmar interossei (three) adduct; dorsal interossei (four) abduct — PAD and DAB; all ulnar nerve
- × All four lumbricals are supplied by the ulnar nerve
- ✓ Lateral two lumbricals: median nerve; medial two: ulnar nerve
- × Lumbricals simply flex the fingers
- ✓ Lumbricals flex the MCP joints while extending the interphalangeal joints

Palmar Aponeurosis

Overall structure	A triangular fibrous sheet in the centre of the palm.
Digital slips	Distal divisions that pass toward the fingers and blend with fibrous digital sheaths.
Protection	Shields deeper tendons, nerves and vessels in the palm.
Support	Helps bind palmar skin firmly and supports an effective grip.

Palmar Arches

- The superficial palmar arch is formed mainly by the ulnar artery and lies more superficially and distally in the palm.
- The deep palmar arch is formed mainly by the radial artery and lies deeper and more proximal.
- The superficial arch supplies most of the palm and the digital arteries to the fingers.
- The deep arch supplies the deep structures of the palm and contributes importantly to the thumb and index finger.
- Injury to either arch may cause severe haemorrhage, and collateral supply may be incomplete.

Thenar Eminence

- The thenar eminence forms the muscular prominence at the base of the thumb.
- Its three muscles are abductor pollicis brevis, flexor pollicis brevis and opponens pollicis.
- Abductor pollicis brevis abducts the thumb, flexor pollicis brevis flexes it, and opponens pollicis produces opposition.
- These muscles are supplied predominantly by the recurrent branch of the median nerve.

Wrist Joint Movements

- Wrist flexion is produced mainly by flexor carpi radialis and flexor carpi ulnaris.
- Wrist extension is produced mainly by extensor carpi radialis longus, extensor carpi radialis brevis and extensor carpi ulnaris.
- Wrist adduction is chiefly by flexor carpi ulnaris and extensor carpi ulnaris.
- Wrist abduction is chiefly by flexor carpi radialis with extensor carpi radialis longus and brevis.

Digital Attachments of Long Tendons

Extensor Tendon Attachments

Extensor expansion	Dorsal tendon-aponeurotic mechanism transmitting force from long extensors and intrinsic hand muscles.
Intrinsic muscle contribution	Lumbricals and interossei feed into the expansion and its lateral components.
Central slip	Attachment to the base of the middle phalanx.
Terminal extensor tendon	Attachment to the base of the distal phalanx.
Terminal tendon division	Mallet finger: failure of active distal interphalangeal extension.

Central slip division	Impaired proximal interphalangeal extension with risk of boutonnière deformity.
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ The central slip inserts into the distal phalanx
- ✓ Central slip: base of middle phalanx; terminal extensor tendon: base of distal phalanx
- ✗ Boutonnière deformity results from terminal extensor tendon rupture
- ✓ Boutonnière reflects central slip failure with altered extensor expansion balance; terminal tendon rupture causes mallet finger

Flexor Tendon Attachments

FDS attachment	Sides of middle phalanx after splitting around FDP
FDP attachment	Palmar base of distal phalanx
Zone 1	Only FDP present distal to the FDS insertion
Zone 1 clinical effect	Loss of active DIP flexion; jersey finger pattern
Zone 2	Both FDS and FDP may be divided

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Loss of active DIP flexion after a distal tendon injury is mallet finger
- ✓ That is jersey finger (FDP, zone 1); mallet finger is an extensor (terminal tendon) lesion
- ✗ FDS inserts into the distal phalanx and FDP into the middle phalanx
- ✓ FDS splits to insert on the middle phalanx; FDP continues to the palmar base of the distal phalanx
- ✗ All finger flexor tendon injuries give the same deficit regardless of level
- ✓ Deficit depends on wound level: zone 1 FDP only (DIP flexion lost); zone 2 FDS and FDP may be divided

Innervation of the Upper Limb

Dermatomal (Segmental) Supply

C5	Lateral antecubital region
C6	Thumb
C7	Middle finger
C8	Little finger
T1	Medial antecubital region
C5	Lateral upper arm
T1	Medial forearm and arm

EXAM TRAPS × tempting option ✓ correct answer

- ✗ C7 dermatome includes the thumb
- ✓ C6 = thumb, C7 = middle finger, C8 = little finger
- ✗ A dermatome is the same as a named peripheral nerve's cutaneous territory
- ✓ Dermatomes are segmental (spinal root) territories, distinct from peripheral nerve cutaneous fields

Muscular Innervation

Elbow flexion	Musculocutaneous nerve; C5/C6
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Elbow extension	Radial nerve; C7
Wrist flexion	Median and ulnar nerves
Wrist extension	Radial nerve
Wrist adduction	Ulnar contribution prominent; radial-nerve extensor carpi ulnaris also assists
Finger movements	Median and ulnar for flexion/intrinsic hand control; radial nerve for extension

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Wrist flexion is supplied by the median nerve alone
- ✓ Median and ulnar nerves (flexor carpi radialis and flexor carpi ulnaris)
- ✗ Wrist adduction is a purely ulnar nerve action
- ✓ Ulnar (flexor carpi ulnaris) plus radial nerve via extensor carpi ulnaris
- ✗ Finger movements depend only on median and ulnar nerves
- ✓ Median and ulnar for flexion/intrinsics; finger extension depends on the radial nerve

Nerve Injury Patterns

Erb's palsy	C5-C6 traction injury; waiter's tip posture; deltoid, supraspinatus, infraspinatus, biceps, brachialis and brachioradialis affected
All-root plexus lesion	Complete upper-limb paralysis
Axillary nerve	Weak abduction; regimental badge sensory loss
Radial nerve at spiral groove	Wrist drop; loss of finger/thumb extension; dorsal hand / first web space sensory loss
Ulnar nerve	Ulnar claw of ring and little fingers; medial 1.5-digit sensory loss; Froment's sign
Median nerve	Carpal tunnel: thenar wasting and loss of opposition; proximal lesion adds forearm flexor and pronator weakness

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Erb's palsy paralyses the entire upper limb
- ✓ Erb's palsy is a C5-C6 upper plexus lesion (waiter's tip); all-root lesions cause complete limb paralysis
- ✗ Axillary nerve injury causes weak abduction without sensory loss
- ✓ Sensory loss over the regimental badge area is a key localising sign
- ✗ Radial nerve injury at the spiral groove causes wrist drop only
- ✓ Also loss of finger/thumb extension and dorsal hand/first web space sensory loss
- ✗ Ulnar palsy spares every thumb-region intrinsic muscle
- ✓ Adductor pollicis and deep head of flexor pollicis brevis are ulnar-supplied (hence Froment's sign)
- ✗ The benediction-type hand is a resting posture
- ✓ Classic benediction pattern is seen on attempted fist formation

ANATOMY • TOPIC 2 OF 7

Lower Limb

Hip Joint and Gluteal Region

Cutaneous Innervation of the Gluteal Region

Main principle	Mixed cutaneous supply from posterior and anterior rami
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Posterior rami	Major contribution to superior and medial gluteal skin
Anterior rami	Contribution to lower gluteal skin
Dermatomal pattern	Broad lumbar-to-sacral sensory transition with overlap

Gluteal and Piriformis Muscles

Muscle	High-yield action	Innervation
Gluteus maximus	Extension and lateral rotation	Inferior gluteal nerve
Gluteus medius	Abduction; pelvic stabilisation	Superior gluteal nerve
Gluteus minimus	Abduction; medial rotation contribution; pelvic stabilisation	Superior gluteal nerve
Piriformis	Lateral rotation; abduction in flexion; hip stabilisation	Nerve to piriformis

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Gluteus maximus is supplied by the superior gluteal nerve
- ✓ Inferior gluteal nerve; gluteus medius and minimus are supplied by the superior gluteal nerve
- ✗ Piriformis acts only as a lateral rotator of the hip
- ✓ It also abducts the hip when flexed and stabilises the hip
- ✗ Piriformis is the only deep lateral rotator of the hip
- ✓ Obturator internus, the gemelli and quadratus femoris are also deep lateral rotators

Hip Joint Movements

Flexion	Iliopsoas.
Extension	Gluteus maximus and hamstrings.
Adduction	Adductor longus, brevis, and magnus.
Abduction	Gluteus medius and minimus.
Medial rotation	Anterior fibres of gluteus medius/minimus; tensor fasciae latae assists.
Lateral rotation	Gluteus maximus plus deep lateral rotators.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Adductor longus, brevis and magnus abduct the hip
- ✓ They adduct the thigh; gluteus medius and minimus abduct it
- ✗ Gluteus maximus is primarily a hip abductor
- ✓ Gluteus maximus is primarily an extensor and lateral rotator; medius and minimus abduct
- ✗ Hip medial and lateral rotation share the same prime movers
- ✓ Medial: anterior gluteus medius/minimus (tensor fasciae latae assists); lateral: gluteus maximus and deep rotators

Hip Joint

Acetabular bones	Ilium, ischium, pubis.
Named stabilising ligaments	Transverse acetabular ligament, ligamentum teres, iliofemoral, pubofemoral, ischiofemoral.
Capsule and synovium blood supply	Periarticular branches from medial and lateral circumflex femoral arteries and superior/inferior gluteal arteries.

Hip joint nerve supply	Distributed articular supply, especially femoral and obturator anteriorly, with posterior contributions from nerve to quadratus femoris, sciatic, and superior gluteal nerves.
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ Ligamentum teres is the dominant stabiliser of the adult hip
- ✓ It is a minor contributor; the capsular ligaments (iliofemoral, pubofemoral, ischiofemoral) dominate
- ✗ Capsule/synovium and femoral head share one identical blood supply
- ✓ They are separate; capsule and synovium receive periarticular circumflex femoral and gluteal branches

Sciatic Nerve

Roots	L4-S3
Buttock entry	Through greater sciatic foramen; usually inferior to piriformis
Entry surface guide	Lower-middle region of line from PSIS to ischial tuberosity
Top of posterior thigh	Approximately midway between ischial tuberosity and greater trochanter
Injection relevance	Avoid inferomedial gluteal region; superolateral quadrant is the classic safer relation to the nerve

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The sciatic nerve arises from sacral roots only
- ✓ Sciatic nerve roots are L4–S3
- ✗ At the top of the posterior thigh the nerve lies on the PSIS–ischial tuberosity line
- ✓ That line marks buttock entry; at the thigh top it lies midway between ischial tuberosity and greater trochanter
- ✗ The upper outer buttock quadrant is completely risk-free for injection
- ✓ It is only the safer relation to the sciatic nerve; avoid the inferomedial gluteal region

Anterior Thigh

Anterior Thigh Muscles

Hip flexion	Iliacus and psoas major are the dominant contributors; sartorius and pectineus also assist.
Rotation	Not uniform across the hip flexors: sartorius laterally rotates; pectineus may assist medial rotation.
Sartorius	Hip flexion, abduction and lateral rotation; knee flexion; femoral nerve.
Pectineus	Hip flexion and adduction; usually femoral nerve, with variable additional contribution.
Quadriceps femoris	Main knee extensor group; all components supplied by femoral nerve.
Rectus femoris	Extends knee and flexes hip.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ All anterior thigh hip flexors share the same rotational action
- ✓ Sartorius laterally rotates; pectineus may assist medial rotation
- ✗ Rectus femoris only extends the knee
- ✓ Rectus femoris extends the knee and flexes the hip
- ✗ Pectineus is purely supplied by the obturator nerve
- ✓ Usually femoral nerve, with variable additional contribution

Femoral Artery

Point of entry into thigh	Beneath the inguinal ligament
Surface marking	Mid-inguinal point
Landmark definition	Halfway between anterior superior iliac spine and pubic symphysis

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The femoral artery enters the thigh at the midpoint of the inguinal ligament
- ✓ Mid-inguinal point: halfway between anterior superior iliac spine and pubic symphysis

Femoral Nerve

Root derivation	L2, L3, L4
Point of entry into thigh	Deep to inguinal ligament
Surface relation	Lateral to the femoral artery at the groin
Superficial division	Mainly cutaneous contribution in the anterior thigh
Deep division	Mainly muscular contribution; source of saphenous nerve
Saphenous nerve	Distal cutaneous continuation of femoral nerve supply

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The femoral nerve lies within the femoral sheath
- ✓ It lies lateral to the femoral sheath and vessels
- ✗ The femoral nerve is purely motor
- ✓ It has important cutaneous branches, including anterior thigh supply and the saphenous nerve

Femoral Sheath

Origin	Downward continuation of extraperitoneal fascial planes beneath the inguinal ligament.
Surface marking	Upper anterior thigh around the femoral vessels near the mid-inguinal point.
Femoral canal	Medial compartment of the femoral sheath.
Femoral ring	Proximal opening of the canal.
Clinical relevance	Route by which a femoral hernia enters the thigh.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The femoral ring is part of the inguinal canal
- ✓ Femoral ring is the proximal opening of the femoral canal, the medial compartment of the femoral sheath
- ✗ A femoral hernia passes above the inguinal ligament
- ✓ It passes below the inguinal ligament through the femoral ring into the femoral canal
- ✗ The femoral sheath is a long fascial tube running through the thigh
- ✓ It is a short proximal sleeve continuing extraperitoneal fascia beneath the inguinal ligament

Femoral Vein

Surface marking	Just medial to the femoral arterial pulsation in the proximal groin
Clinical significance	Important anatomical landmark for central venous access

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Proximally the femoral vein lies lateral to the femoral artery
- ✓ Femoral vein lies just medial to the femoral artery in the proximal groin

Lymph Nodes and Vessels

Superficial group	Superficial groin nodes just inferior to the inguinal ligament.
Superficial drainage	Broad superficial field: lower limb plus adjacent superficial abdominal, gluteal, perineal, and external genital territories.
Deep group	Deep proximal femoral nodes close to the femoral vein.
Deep drainage	Deep lymphatic channels of the lower limb and deeper groin tissues.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Superficial and deep inguinal nodes are distinguished by drainage alone
- ✓ They differ in position: superficial just below the inguinal ligament; deep close to the femoral vein
- ✗ Deep inguinal nodes lie in the superficial groin tissues
- ✓ Deep inguinal nodes lie close to the femoral vein in the proximal thigh

Patellar Region

Patellar ligament	Strong band from patella to tibial tuberosity; distal part of the knee extensor mechanism.
Patella	Sesamoid bone within the quadriceps tendon.
Bony stability	Trochlear morphology guides the patella and resists lateral draw.
Ligamentous stability	Medial patellofemoral and retinacular restraints resist lateral displacement.
Muscular stability	Vastus medialis contributes a medial stabilising pull.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The patellar ligament lies above the patella
- ✓ Quadriceps tendon lies above the patella; patellar ligament runs from patella to tibial tuberosity
- ✗ Lateral patellar stability depends on a single factor
- ✓ Restraint is bony (trochlea), ligamentous (medial patellofemoral/retinacula) and muscular (vastus medialis)

Superficial Arteries

Arterial source	Cutaneous arteries arising from the femoral artery
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Superficial Innervation

Core sequence	L1 proximally, L2 through the mid anterior thigh, L3 distally near the medial knee.
Most useful anchor	L2 at the mid anteromedial thigh; L3 at the medial femoral condyle above the knee.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anterior thigh dermatomes match named cutaneous nerve territories
- ✓ Dermatomes are segmental (L1, L2, L3), distinct from peripheral cutaneous nerve territories
- ✗ Dermatomal boundaries are exact lines
- ✓ They are broad, overlapping sensory zones

Superficial Veins

Principal vein	Great saphenous vein
Surface marking	Medial knee to anteromedial thigh to proximal medial groin
Termination	Saphenofemoral junction after passing through the saphenous opening
Tributary pattern	Several superficial tributaries converge proximally; arrangement is variable

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The great saphenous vein runs on the lateral thigh
- ✓ It runs from the medial knee up the anteromedial thigh to the saphenofemoral junction
- ✗ The great saphenous vein is a deep vein
- ✓ It is superficial; it joins the deep femoral vein at the saphenofemoral junction via the saphenous opening
- ✗ Proximal great saphenous tributaries follow a fixed pattern
- ✓ Several tributaries converge proximally, but the arrangement is variable

Medial Thigh

Arteries and Nerves of the Medial Thigh

Profunda femoris artery	Principal deep arterial supply for the medial thigh region
Obturator artery	Supplementary arterial supply to the medial compartment
Obturator nerve	Motor supply to the adductor compartment; sensory supply to medial thigh skin

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The femoral nerve is the dominant nerve of the medial thigh
- ✓ Obturator nerve: motor to the adductor compartment and sensory to medial thigh skin
- ✗ The obturator artery is the principal artery of the medial thigh
- ✓ Profunda femoris is principal; the obturator artery is supplementary

Medial Thigh Muscles

Prime adductors	Adductor longus, adductor brevis, adductor magnus.
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Primary movement	Hip adduction.
Additional rotational role	Assistance with medial femoral rotation.
Adductor magnus nuance	Adductor portion: obturator nerve; hamstring portion: tibial division of sciatic nerve.
Obturator externus	Lateral rotator of the femur; obturator nerve supplied.
Clinical test	Resisted thigh adduction.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Obturator externus is a medial rotator of the femur
- ✓ Obturator externus laterally rotates the femur; obturator nerve
- ✗ All of adductor magnus is supplied by the obturator nerve
- ✓ Adductor part: obturator nerve; hamstring part: tibial division of the sciatic nerve

Posterior Thigh

Hamstring Muscles

Muscles	Biceps femoris, semitendinosus, semimembranosus.
Shared group actions	Knee flexion and hip extension.
Important exception	Short head of biceps femoris contributes to knee flexion only.
Tibial division supply	Semitendinosus, semimembranosus, long head of biceps femoris.
Common fibular/peroneal supply	Short head of biceps femoris.
Clinical test	Resisted knee flexion.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Every part of biceps femoris extends the hip
- ✓ The short head crosses only the knee, so it flexes the knee only
- ✗ All hamstrings are supplied by the tibial division of the sciatic nerve
- ✓ Short head of biceps femoris is supplied by the common fibular (peroneal) division

Sciatic Nerve in the Posterior Thigh

Surface course	Deep line descending from the upper posterior thigh towards the popliteal region
Main regional role	Motor supply within the posterior thigh
Main muscles supplied	Semitendinosus, semimembranosus, biceps femoris, hamstring part of adductor magnus
Key exception	Short head of biceps femoris supplied through the common fibular component
Common misconception	Posterior thigh skin sensation is mainly posterior femoral cutaneous, not direct sciatic supply

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The short head of biceps femoris shares tibial division supply with other hamstrings
- ✓ It is supplied via the common fibular component of the sciatic nerve

Popliteal Fossa and Knee

Knee Joint

Condylar anatomy	Adapted for screw-home movement in terminal extension.
Capsular openings	Popliteus tendon; suprapatellar bursal communication.
Medial stability	Tibial collateral ligament resists valgus stress.
Lateral stability	Fibular collateral ligament resists varus stress.
Cruciate ligaments	ACL limits anterior tibial translation; PCL limits posterior tibial translation.
Menisci	Load distribution, shock absorption, improved congruity, stability.
Communicating bursae	Suprapatellar and popliteus bursae are key direct communications; posteromedial communication may occur via the medial gastrocnemius–semimembranosus bursa.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The medial collateral ligament resists varus stress
- ✓ Medial (tibial) collateral resists valgus; lateral (fibular) collateral resists varus
- ✗ Every named bursa around the knee communicates with the joint cavity
- ✓ Key communications are suprapatellar and popliteus bursae; medial gastrocnemius–semimembranosus bursa only may communicate

Knee Movements

Screw-home mechanism	Coupled rotation in terminal extension that produces locking.
Locked knee	Most stable in full extension; less muscular effort is required to maintain the posture.
Menisci in flexion	Move posteriorly.
Menisci in extension	Move anteriorly.
Tibial spines	Provide central bony contouring around the intercondylar region.
Cruciate ligaments	Restrain excessive anterior/posterior tibial translation and contribute to rotational control.
Muscles	Provide dynamic stability during movement.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Screw-home rotation looks the same in open-chain and weight-bearing movement
- ✓ Apparent direction differs: tibia rotates on femur in open chain; femur rotates on fixed tibia when weight-bearing
- ✗ The menisci are fixed wedges during knee movement
- ✓ Menisci move posteriorly in flexion and anteriorly in extension
- ✗ Knee stability is purely ligamentous
- ✓ Muscles provide essential dynamic stability alongside ligaments and menisci

Popliteal Fossa

Shape	Diamond-shaped posterior knee fossa
Upper boundaries	Semimembranosus/semiotendinosus medially; biceps femoris laterally
Lower boundaries	Medial and lateral heads of gastrocnemius

Central order (superficial to deep)	Tibial nerve → popliteal vein → popliteal artery
Common peroneal nerve	Along biceps femoris medial border in the lateral fossa

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The popliteal artery is the most superficial central structure in the popliteal fossa
- ✓ Superficial to deep: tibial nerve, popliteal vein, popliteal artery
- ✗ The common peroneal nerve lies in the central neurovascular stack
- ✓ It runs laterally along the medial border of biceps femoris
- ✗ The popliteal pulse is as easy to feel as a superficial artery
- ✓ It lies deep in the fossa (deepest central structure), so is often difficult to palpate

Popliteus Muscle

Nerve supply	Tibial nerve
Primary action	Medial rotation of tibia on femur
Mechanical significance	Unlocks the extended knee to initiate flexion
Meniscal relationship	Assists posterior movement of the lateral meniscus during flexion

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Popliteus rotates the tibia in the same way whether or not weight-bearing
- ✓ Non-weight-bearing: medially rotates tibia on femur; weight-bearing: laterally rotates femur on tibia; both unlock the knee

Anterior Leg

Anterior Leg Muscles

Anterior compartment muscles	Tibialis anterior, EHL, EDL, fibularis tertius.
Shared innervation	Deep fibular nerve.
Core compartment action	Ankle dorsiflexion.
Toe extensors	EHL extends the great toe; EDL extends the lateral four toes.
Pes anserinus tendons	Sartorius, gracilis, semitendinosus insert on the proximal medial tibia.
Patellar ligament	Inferior patella to tibial tuberosity.
Patellar bursae	Suprapatellar, prepatellar, superficial infrapatellar, deep infrapatellar.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Sartorius, gracilis and semitendinosus are anterior compartment leg muscles
- ✓ They are thigh muscles inserting on the proximal medial tibia (pes anserinus)
- ✗ Fibularis tertius assists inversion of the foot
- ✓ Tibialis anterior assists inversion; fibularis tertius assists eversion (both deep fibular nerve)
- ✗ The patellar ligament lies above the patella
- ✓ Patellar ligament runs patella to tibial tuberosity; quadriceps tendon lies above the patella

Lateral Leg

Lateral Leg Muscles (Peronei)

Main muscles	Fibularis longus and fibularis brevis
Shared actions	Foot eversion; assistance with plantarflexion
Innervation	Superficial fibular nerve
Relation to lateral malleolus	Both tendons pass posterior to it; brevis lies closest to the fibula
Longus insertion	Medial cuneiform and base of 1st metatarsal
Brevis insertion	Base of 5th metatarsal
Inversion injury link	Peroneal tendon strain; possible avulsion at the 5th metatarsal tuberosity

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Fibularis longus inserts into the base of the 5th metatarsal
- ✓ Brevis: base of 5th metatarsal; longus crosses to medial cuneiform and base of 1st metatarsal
- × Fibularis tendons pass anterior to the lateral malleolus
- ✓ Both pass posterior to the lateral malleolus, brevis closest to the fibula
- × 5th metatarsal base tenderness after inversion reflects fibularis longus traction
- ✓ Traction through fibularis brevis, which inserts there, can avulse the 5th metatarsal tuberosity

Posterior Leg (Calf)

Calf Muscle Groups

Superficial group	Gastrocnemius and soleus
Deep group	Tibialis posterior, flexor digitorum longus, flexor hallucis longus
Cross-sectional concept	Superficial muscles posteriorly; deep posterior muscles and vessels lie deeper within the calf
Clinical anatomy	Soleus-associated deep veins are important sites for DVT formation

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Gastrocnemius alone forms the superficial posterior calf group
- ✓ Gastrocnemius and soleus together form the superficial posterior group; soleus is a major component
- × Calf DVT typically arises in superficial subcutaneous veins
- ✓ Deep soleal veins are the key DVT sites, not superficial subcutaneous veins

Calf Muscles

Major plantarflexors	Gastrocnemius and soleus.
Biarticular calf muscle	Gastrocnemius: plantarflexes ankle and flexes knee.
Single-joint major plantarflexor	Soleus: plantarflexes ankle.
Flexor of lateral four toes	Flexor digitorum longus.
Great toe flexor	Flexor hallucis longus.
Principal deep invertor	Tibialis posterior.
Shared nerve supply	Tibial nerve.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Soleus flexes the knee
- ✓ Gastrocnemius flexes the knee (biarticular); soleus acts only on the ankle
- ✗ Flexor digitorum longus flexes the great toe
- ✓ Flexor hallucis longus flexes the great toe; flexor digitorum longus flexes the lateral four toes
- ✗ Tibialis posterior is an evor of the foot
- ✓ Tibialis posterior is primarily an inverter of the foot

Posterior Tibial Artery

Origin concept	Derived from the popliteal artery
Region	Posterior leg
Surface marking	Immediately posterior to the medial malleolus

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The pulse posterior to the medial malleolus is dorsalis pedis
- ✓ Posterior tibial artery lies behind the medial malleolus; dorsalis pedis is on the dorsum of the foot

Tibial Nerve in the Calf

Nerve	Tibial nerve
Core role	Nerve of the calf flexor compartment
Surface course	Posterior leg, descending from popliteal region towards the posteromedial ankle
Distal landmark	Behind the medial malleolus, between it and the calcaneal (Achilles) tendon

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The nerve in the posterior calf runs laterally towards the fibular neck
- ✓ Tibial nerve descends posteriorly to the posteromedial ankle; the common fibular nerve winds laterally round the fibular neck

Ankle and Foot Joints and Dynamics

Ankle Joint

Weightbearing surfaces	Inferior tibia and superior talus
Bony stabilisers	Medial and lateral malleoli
Medial ligament	Deltoid ligament
Lateral ligament complex	Anterior talofibular, calcaneofibular and posterior talofibular ligaments
Core stability principle	Mortise containment plus medial and lateral ligamentous restraint

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The fibula is the main weightbearing bone transmitting load to the talus
- ✓ Tibia transmits load to the talus; inferior tibia and superior talus are the weightbearing surfaces
- ✗ The lateral ankle ligament is a single structure
- ✓ Three distinct bands: anterior talofibular, calcaneofibular and posterior talofibular ligaments
- ✗ The deltoid ligament has a single distal insertion
- ✓ Deltoid ligament has a broad, fan-like medial attachment pattern

Ankle Movements

Stable position	Dorsiflexion.
Reason for stability	Wider anterior talar dome is held more firmly within the ankle mortise.
Less stable position	Plantarflexion.
Reason for reduced stability	Narrower posterior talus occupies the mortise.
Movement axis	Talocrural transverse-oblique axis close to the malleolar line.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The ankle is most stable in plantarflexion
- ✓ Most stable in dorsiflexion: the wider anterior talar dome is gripped by the mortise
- ✗ The ankle mortise is equally congruent throughout its range
- ✓ Fit varies with talar shape: wide anterior dome in dorsiflexion, narrower posterior talus in plantarflexion
- ✗ The ankle moves about a fixed, purely transverse axis
- ✓ Approximately transverse, slightly oblique talocrural axis close to the malleolar line

Foot Movements and Arches

Inversion joints	Subtalar and midtarsal joints
Eversion joints	Subtalar and midtarsal joints
Midtarsal joint	Talonavicular + calcaneocuboid
Subtalar joint	Talocalcaneal
Invertors	Tibialis anterior and tibialis posterior
Evertors	Peroneus longus and peroneus brevis
Standing contact points	Heel, lateral border, metatarsal heads, toes
Medial arch	Calcaneus, talus, navicular, three cuneiforms, three medial metatarsals
Lateral arch	Calcaneus, cuboid, two lateral metatarsals

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Inversion and eversion occur mainly at the ankle (talocrural) joint
- ✓ Inversion and eversion occur at the subtalar and midtarsal joints
- ✗ The midtarsal joint is the talocalcaneal joint
- ✓ Midtarsal = talonavicular + calcaneocuboid; subtalar = talocalcaneal
- ✗ Ligaments alone maintain the medial longitudinal arch
- ✓ Medial arch also relies on dynamic muscular and tendinous support, not ligaments alone

Tarsal Joints

Tarsal bones	Talus, calcaneus, navicular, cuboid, medial cuneiform, intermediate cuneiform, lateral cuneiform.
Medial sequence	Talus → navicular → cuneiform region.
Lateral sequence	Calcaneus → cuboid.
Deep stabilisers	Interosseous and plantar ligaments bind and support the tarsal complex.
Spring ligament	Plantar calcaneonavicular support beneath the talar head; maintains the medial arch.

Dorsum of the Foot

Cutaneous Innervation of the Dorsum

Main dorsum dermatome	L5.
Medial adjacent segment	L4.
Lateral adjacent segment	S1.
Main dorsal cutaneous nerve	Superficial fibular nerve.
First web-space nerve	Deep fibular nerve.
Margins	Saphenous nerve medially; sural nerve laterally.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The L5 dermatome and superficial fibular nerve territory are the same thing
- ✓ L5 is a spinal-root (dermatomal) map; superficial fibular nerve is a named peripheral cutaneous nerve
- ✗ The first dorsal web space is supplied by the superficial fibular nerve
- ✓ Deep fibular nerve supplies the first dorsal web space

Dorsalis Pedis Artery

Continuity	Continuation of the anterior tibial artery at the ankle joint
Surface marking	Anterior ankle midway between the malleoli, then across the dorsum towards the proximal first intermetatarsal space
Practical landmark	Usually sought just lateral to the tendon of extensor hallucis longus

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Dorsalis pedis runs behind the malleoli
- ✓ Dorsalis pedis runs on the anterior ankle midway between the malleoli and across the dorsum of the foot
- ✗ Dorsalis pedis is a continuation of the posterior tibial artery
- ✓ Dorsalis pedis is the continuation of the anterior tibial artery at the ankle joint

Sole of the Foot

Individual Muscles of the Sole

Feature	Fibularis longus	Tibialis posterior
Main side-to-side action	Eversion	Inversion
Additional action	Assists plantarflexion	Assists plantarflexion
Nerve supply	Superficial fibular nerve	Tibial nerve
Key insertion	Medial cuneiform and base of 1st metatarsal	Navicular tuberosity with wider slips to adjacent midfoot and metatarsal bones

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Fibularis longus inverts and tibialis posterior everts the foot
- ✓ Fibularis longus everts; tibialis posterior inverts
- ✗ Fibularis longus inserts on the lateral side of the foot
- ✓ Fibularis longus inserts medially, on the medial cuneiform and base of the 1st metatarsal
- ✗ Tibialis posterior inserts at a single point
- ✓ Navicular tuberosity, with wider slips to adjacent midfoot and metatarsal bones

Layered Structure of the Sole

Layer 1	Abductor hallucis, flexor digitorum brevis, abductor digiti minimi
Layer 2	Flexor digitorum longus, flexor hallucis longus, quadratus plantae, lumbricals
Layer 3	Short muscles of the great and little toes
Layer 4	Interossei; tibialis posterior and fibularis longus tendons
Injury relevance	Plantar neurovascular structures occupy an intermediate vulnerable plane, so sole wounds can damage vessels and nerves.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The long flexor tendons lie in the fourth (deepest) layer of the sole
- ✓ Flexor digitorum longus and flexor hallucis longus tendons are in layer 2
- ✗ Layer 4 of the sole contains only the interossei
- ✓ Layer 4: interossei plus tibialis posterior and fibularis longus tendons
- ✗ Plantar neurovascular structures lie deep and are rarely injured in sole wounds
- ✓ They occupy an intermediate, vulnerable plane, so sole wounds can damage them

Lower Limb Innervation (Nerve Injury Patterns)

Clinical Effects of Nerve Damage

Nerve	Signature deficit	Sensory territory
Femoral	Knee extension lost	Anteromedial thigh; medial leg
Lateral femoral cutaneous	Meralgia paraesthetica; no motor loss	Anterolateral thigh
Obturator	Hip adduction weak	Medial thigh

Nerve	Signature deficit	Sensory territory
Sciatic	Distal lower-limb movement severely impaired	Below knee except medial leg
Common fibular	Foot drop	Dorsum of foot; anterolateral leg

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Lateral femoral cutaneous nerve injury weakens the quadriceps
- ✓ Lateral femoral cutaneous is sensory only (meralgia paraesthetica); femoral injury causes quadriceps/knee extension loss
- ✗ Femoral nerve injury abolishes all hip flexion
- ✓ Hip flexion is reduced, not abolished, because psoas major is not supplied by the femoral nerve
- ✗ Sciatic nerve injury causes sensory loss over the entire leg below the knee
- ✓ Medial leg is spared, being supplied by the saphenous nerve (femoral)
- ✗ Foot drop results from loss of plantarflexion
- ✓ Foot drop results from loss of dorsiflexion (common fibular nerve)

Lower Limb Osteology

Radiological Anatomy

Lower-limb long bones	Femur, tibia, fibula
Key additional bones	Patella; talus and calcaneus at the hindfoot
Foot bone groups	Tarsals, metatarsals, phalanges
Normal radiographic pattern	Continuous cortex and preserved alignment
Fracture clues	Lucent line, cortical break, angulation, displacement, overlap, comminution

ANATOMY · TOPIC 3 OF 7

Thorax

Thoracic Wall

Bony Thoracic Wall

Primary bony framework	Ribs linked anteriorly by costal cartilages and posteriorly to thoracic vertebrae.
Costovertebral articulation	Joint involving the rib head and vertebral body region.
Costotransverse articulation	Joint involving the rib tubercle and thoracic transverse process.
First rib	Articulates with T1 only; not with C7.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The first rib articulates with C7
- ✓ First rib articulates with T1 only; a cervical rib is associated with C7

Dermatomal Innervation of Thoracic Wall

T4	Nipple line
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T6	Xiphisternal region
T10	Umbilicus
T12	Suprapubic region
Pattern	Segmental horizontal bands around the trunk
Upper thoracic reference	T1-T3 over the superior thoracic wall and axillary region

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Dermatomes correspond to named peripheral nerve territories
- ✓ Dermatomes are spinal segmental bands, distinct from named peripheral nerve cutaneous territories
- ✗ The umbilicus lies in the T9 or T11 dermatome
- ✓ T10 dermatome corresponds to the umbilicus
- ✗ Dermatome borders are exact lines
- ✓ Dermatomes overlap; borders are zones, not sharp lines

Intercostal Structures

Main neurovascular plane	Between internal and innermost intercostal muscles.
Bundle order	Vein, artery, nerve from superior to inferior.
Protected location	Costal groove along the inferior margin of the rib above.
Pleural aspiration rule	Enter just above the rib below.
Chest drain landmark	Safe triangle of the lateral chest wall.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The needle should pass just below a rib
- ✓ Insert just above the rib below, avoiding the bundle in the costal groove of the rib above
- ✗ The intercostal neurovascular bundle lies between external and internal intercostals
- ✓ Between the internal and innermost intercostal muscles
- ✗ The safe triangle is a posterior chest wall landmark
- ✓ Safe triangle is on the lateral chest wall

Muscle Layers of the Thoracic Wall

Outer thoracic wall layer	External intercostal muscles
Intermediate thoracic wall layer	Internal intercostal muscles
Innermost thoracic wall layer	Innermost intercostals and transversus thoracis

Thoracic Movements (Respiration)

Main inspiratory actions	Diaphragm descent and rib elevation by external intercostals
Main expiratory principle	Passive recoil in quiet breathing; active muscle contribution in forced expiration
Pump handle	Upper rib elevation moves sternum forwards and upwards
Bucket handle	Lower rib elevation moves ribs laterally
Abdominal wall in inspiration	Normally moves outwards
Central respiratory control	Brainstem rhythm generation with pontine modulation

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Pump-handle movement increases transverse thoracic diameter
- ✓ Pump-handle (upper ribs) increases anteroposterior diameter; bucket-handle (lower ribs) increases transverse diameter
- × Quiet expiration is an active muscular process
- ✓ Quiet expiration is mainly passive elastic recoil; muscles act only in forced expiration
- × The abdominal wall moves inwards during normal inspiration
- ✓ Moves outwards, because the diaphragm descends and displaces abdominal contents

Thoracic Osteology

Ribs

Rib count	12 pairs
Anterior grouping	True 1-7, false 8-10, floating 11-12
Costal groove	Inferior internal rib surface; houses main intercostal neurovascular bundle
Respiratory role	Ribs and sternum form a moving protective cage that changes thoracic dimensions
Major injury consequence	Flail chest: unstable segment with paradoxical movement

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Ribs 8–10 are floating ribs
- ✓ Ribs 11–12 are floating (no anterior attachment); 8–10 are false ribs
- × The intercostal bundle runs along the superior border of the rib below
- ✓ Runs in the costal groove along the inferior border of the rib above
- × The sternum is static during respiration
- ✓ Sternum moves with the ribs as part of the mobile respiratory cage (forwards and upwards in pump-handle movement)

Thoracic Inlet

Anatomy of the Thoracic Inlet

Central visceral relation	Trachea anterior; oesophagus posterior.
Arch branches	Brachiocephalic trunk, left common carotid, left subclavian.
Right subclavian artery	Branch of brachiocephalic trunk.
Left subclavian artery	Direct branch of aortic arch.
Subclavian veins	More anterior than the corresponding arteries.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The left subclavian artery arises from the brachiocephalic trunk
- ✓ Right subclavian arises from the brachiocephalic trunk; left arises directly from the aortic arch
- × The thoracic inlet is spacious, so pathology affects single structures
- ✓ Compact inlet: local disease or injury can affect airway, oesophagus and major vessels together

Diaphragm

Actions of the Diaphragm

Primary inspiratory action	Contraction and descent of the diaphragm
Thoracic effect	Increase in vertical thoracic diameter
Pressure effect in inspiration	Reduced intrathoracic pressure draws air into the lungs
Straining role	Helps raise intra-abdominal pressure
Valsalva principle	Pressure generation against a closed glottis with coordinated thoracoabdominal muscular action

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The diaphragm functions only as a breathing muscle
- ✓ It also raises intra-abdominal pressure during straining (e.g. Valsalva)
- ✗ Quiet inspiration is passive
- ✓ Quiet inspiration depends on active diaphragmatic contraction and descent

Diaphragm Function and Markings

Primary role	Main muscle of quiet inspiration
Inspiratory action	Contracts and descends, increasing thoracic volume
Resting shape	Paired domes; right dome usually higher
Right dome surface marking	Upper border of 5th rib, midclavicular line
Left dome surface marking	Lower border of 5th rib, midclavicular line

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ At rest the diaphragm is a flat sheet at the costal margin
- ✓ High domes projecting into the thorax; right dome usually higher (upper border 5th rib MCL)

Diaphragmatic Herniation

Definition	Abdominal viscera enter thorax through a diaphragmatic defect
Congenital form	Developmental failure or abnormal formation of the diaphragm
Acquired form	Later defect, commonly traumatic
Shared anatomical consequence	Loss of normal separation between abdomen and thorax

Diaphragmatic Openings

Vena caval opening	T8
Oesophageal opening	T10
Aortic opening	T12

Innervation

- The diaphragm receives its motor supply from the right and left phrenic nerves.
- The phrenic nerve is derived from C3, C4 and C5, with C4 usually contributing most strongly.

- Each phrenic nerve reaches its own hemidiaphragm and divides into terminal branches over the muscle.
- Most diaphragmatic branching occurs on the inferior aspect of the diaphragm.

Pleura and Lungs

Lungs

Lobes	Right 3; left 2.
Internal organisation	Bronchi and pulmonary arteries travel together; pulmonary veins drain separately.
Roots	Transmit bronchi, pulmonary vessels, bronchial vessels, lymphatics and autonomic nerves.
Fissures	Oblique fissure in both lungs; horizontal fissure only in right lung.
Lymph drainage	Hilar → tracheobronchial → mediastinal groups/trunks.
Nerves	Autonomic pulmonary plexuses; relevant to bronchial stimulation and visceral pain perception.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Both lungs have a horizontal fissure
- ✓ Horizontal fissure is in the right lung only; both have an oblique fissure
- × Pulmonary veins follow the bronchi and pulmonary arteries
- ✓ Bronchi and pulmonary arteries travel together; pulmonary veins drain separately

Pleura

Parietal pleura	Somatic sensory supply; pain-sensitive
Visceral pleura	Autonomic supply; classically insensate to pain
Key recess	Costodiaphragmatic recess
Inferior pleural markings	8th rib MCL, 10th rib MAL, 12th rib paravertebral

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Visceral pleura causes sharp localised pleuritic pain
- ✓ Parietal pleura (somatic supply) is pain-sensitive; visceral pleura (autonomic) is classically insensate to pain
- × The pleural cavity ends at the inferior lung border
- ✓ Pleura extends below the lung, forming the costodiaphragmatic recess where fluid collects

Trachea

Tracheal Structure and Function

Main role	Conducting airway with protective mucociliary clearance
Upper extent	C6 – inferior border of cricoid cartilage
Lower extent	T4/5 – carina
Key wall adaptations	Elastic wall, C-shaped hyaline cartilage, ciliated mucosa
Main thoracic neighbours	Oesophagus, great veins, aortic arch and branches, lungs

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The trachea begins at the thyroid cartilage or hyoid
- ✓ Begins at the inferior border of the cricoid cartilage, C6
- ✗ The tracheal carina lies at T10
- ✓ Carina at approximately T4/5; T10 is the oesophageal hiatus

Heart and Pericardium

Cardiac Blood Supply

Coronary origin	Right and left aortic sinuses within the aortic root
RCA principal branches	Right marginal artery; posterior interventricular artery
RCA nodal supply	Usually SA node and AV node
Left coronary branches	Left anterior descending artery; circumflex artery
LAD territory	Anterior ventricles and anterior interventricular septum
Circumflex territory	Left atrium and lateral/posterior left ventricle

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The coronary arteries arise from the pulmonary trunk
- ✓ They arise from the right and left aortic sinuses of the aortic root
- ✗ The left coronary artery and LAD are the same vessel
- ✓ Left anterior descending (LAD) is a branch of the left coronary artery, alongside the circumflex
- ✗ SA and AV nodes are usually supplied by the left coronary artery
- ✓ Usually the right coronary artery, though anatomical variation exists

Conducting System

Impulse origin	Sinoatrial node
SA node location	Superior right atrium at the superior vena caval junction
AV node location	Lower interatrial septal region near the coronary sinus opening
Ventricular pathway	Atrioventricular bundle dividing into right and left bundle branches
Core function	Orderly spread of excitation from atria to ventricles

Great Vessels

Ascending aorta	Leaves the left ventricle via the aortic orifice.
Pulmonary trunk	Leaves the right ventricle via the pulmonary orifice.
Initial relation	Pulmonary trunk anterior to ascending aorta.
Relation during ascent	Pulmonary trunk passes posteriorly and leftwards; ascending aorta lies relatively to the right.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The pulmonary trunk stays anterior to the ascending aorta throughout
- ✓ Anterior at its origin, then curves posteriorly and leftwards relative to the ascending aorta

Heart Borders and Surface Markings

Right border	Right atrium
Left border	Left ventricle and left auricle
Inferior border	Predominantly right ventricle
Superior border	Great vessels

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Heart surface outline points are the valve auscultation sites
- ✓ Cardiac outline surface markings are separate from valve surface markings and auscultation sites
- ✗ The left heart border is formed mainly by the left atrium
- ✓ Left border is chiefly left ventricle (with left auricle); right border is right atrium

Heart Valve Markings and Auscultation

Valve	Surface marking	Auscultation site
Aortic	Left half of sternum, 3rd intercostal level	2nd right intercostal space, sternal border
Pulmonary	Left 3rd costal cartilage and adjacent sternum	2nd left intercostal space, sternal border
Tricuspid	Lower sternum, 4th-5th intercostal region	Lower left sternal border
Mitral	Left half of sternum, 4th costal cartilage level	5th left intercostal space, midclavicular line

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The aortic valve is auscultated over its anatomical position at the 3rd intercostal level
- ✓ Auscultated at 2nd right intercostal space, sternal border; it lies retrosternally near the 3rd intercostal level

Pericardiocentesis (Procedural Anatomy)

Purpose	Aspiration of fluid from the pericardial cavity
Exam route	Subxiphoid approach
Surface landmark	Left xiphocostal/subxiphoid region
Needle direction	Towards the left shoulder
Traditional angle	Approximately 45 degrees to the skin
Target	Inferior-anterior pericardial sac
Core layers reached	Fibrous pericardium, parietal serous pericardium, then pericardial cavity

Pericardium

Outer layer	Fibrous pericardium
Inner layers	Parietal and visceral serous pericardium
Visceral serous layer	Epicardium
Mechanical role	Supports the heart and limits acute distension
Nerve supply relevant to pain	Phrenic nerves to fibrous/parietal pericardium
Pain distinction	Pericarditis is pericardial/somatic; ACS is myocardial/visceral

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The visceral serous pericardium is the fibrous pericardium
- ✓ Visceral serous pericardium is the epicardium; fibrous pericardium is the outer layer
- ✗ Pericarditis pain travels by the same pathway as ischaemic cardiac pain
- ✓ Pericarditis is somatic (phrenic nerves); acute coronary syndrome pain is visceral myocardial

Oesophagus (Thoracic)

Thoracic Oesophagus

Upper extent	C6
Diaphragmatic passage	T10
Surface marking of passage	Level of 7th costal cartilage
Principal relations	Vertebral bodies, left bronchus, thoracic aorta, pericardium
Constrictions	Cricopharyngeal, aortic, bronchial, diaphragmatic
Nerve relevance	Visceral afferents and referred pain

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The oesophagus passes through the diaphragm at T12
- ✓ Oesophagus at T10; aorta at T12

Thymus

Location	Anterior mediastinum
Pathology relevance	Thymoma; association with myasthenia gravis
Injury relevance	May be implicated in anterior mediastinal trauma
Natural history	Regression after puberty with progressive involution and fatty replacement

Surgical Approach to the Thorax

Thoracotomy Anatomy

Anterolateral thoracotomy	Pectoral/lateral chest wall route into an intercostal space
Posterolateral thoracotomy	Posterolateral muscle-cutting route; latissimus dorsi classically divided
Median sternotomy	Midline longitudinal division of the sternum
Shared thoracotomy risk	Intercostal neurovascular bundle when entering through rib spaces
Sternotomy-specific nearby risks	Internal thoracic vessels, pleura, pericardium, heart

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ A median sternotomy passes through an intercostal space
- ✓ Sternotomy divides the sternum (bone); thoracotomy passes through an intercostal space
- ✗ The intercostal bundle lies along the superior border of the rib below
- ✓ Lies along the inferior border of the rib above
- ✗ Posterolateral thoracotomy divides only skin and fascia
- ✓ It is muscle-cutting; latissimus dorsi is classically divided

ANATOMY · TOPIC 4 OF 7

Abdomen

Abdominal Wall

Abdominal Regions

Number of regions	Nine
Upper row	Right hypochondriac, epigastric, left hypochondriac
Middle row	Right lumbar, umbilical, left lumbar
Lower row	Right iliac, hypogastric, left iliac
Defining lines	Two midclavicular lines, subcostal plane, transtubercular plane

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Abdominal regions are named by the examiner's right and left
- ✓ Always the patient's right and left

Abdominal Wall Muscles

External oblique	Superficial flat muscle; attachments include its broad aponeurosis, whose inferior border forms the inguinal ligament.
Internal oblique	Intermediate flat muscle of the lateral abdominal wall.
Transversus abdominis	Deepest flat muscle; fibres pass mainly transversely into an anterior aponeurosis.
Rectus abdominis	Paired vertical muscle on each side of the linea alba.
Linea alba	Midline fibrous raphe formed by interwoven aponeuroses of the lateral abdominal wall muscles.
Nerve supply	Lower intercostal nerves, plus iliohypogastric and ilioinguinal nerves inferiorly.

Actions of Abdominal Muscles

Truncal movement	Flexion, rotation, and lateral flexion
Forced expiration	Rib depression and compression of abdominal contents
Visceral support	Muscular containment and pressure support of abdominal viscera

Rectus Sheath

Rectus sheath	Aponeurotic compartment of the anterior abdominal wall
Derivation	Aponeuroses of external oblique, internal oblique and transversus abdominis

Nerves	Anterior rami of T7-T12 (thoracoabdominal and subcostal nerves)
Arterial contents	Superior epigastric artery and inferior epigastric artery

Inguinal Region

Inguinal Canal

Canal position	Lower anterior abdominal wall, above the medial half of the inguinal ligament
Roof	Internal oblique and transversus arching fibres
Anterior wall	External oblique aponeurosis
Posterior wall	Transversalis fascia
Floor	Inguinal ligament and lacunar ligament
Superficial ring	Derived from external oblique aponeurosis
Deep ring	Derived from transversalis fascia
Groin neurovascular order	Femoral nerve, artery, vein from lateral to medial
Psoas	Deep muscle passing beneath the inguinal ligament into the thigh

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The superficial inguinal ring derives from transversalis fascia
- ✓ Superficial ring = external oblique aponeurosis; deep ring = transversalis fascia
- × The femoral vein lies lateral to the femoral artery
- ✓ Lateral to medial: femoral nerve, artery, vein

Testis, Epididymis and Spermatic Cord

Gross relation	Epididymis lies posterior to testis and continues into vas deferens.
Cord contents	Vas deferens, testicular artery, pampiniform venous plexus.
Cord coverings	Internal spermatic fascia, cremasteric layer, external spermatic fascia.
Blood supply	Testicular artery from abdominal aorta.
Lymph drainage	Para-aortic / lumbar aortic nodes.
Descent	Failure leads to undescended testis.
Infant hernia basis	Persistent descent-related communication predisposes to indirect inguinal hernia.
Vas deferens	Continuation of epididymal duct; joins seminal vesicle duct to form ejaculatory duct opening into prostatic urethra.
Nerve supply	Visceral autonomic supply via testicular plexus with visceral afferents.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The testis drains to the superficial inguinal nodes
- ✓ Testis drains to para-aortic (lumbar) nodes; the scrotum drains to superficial inguinal nodes
- × The vas deferens opens directly into the prostatic urethra
- ✓ Joins the seminal vesicle duct to form the ejaculatory duct, which opens into the prostatic urethra

Topography of the Abdominal Cavity

Peritoneal Relations of Organs

Intraperitoneal organs	Stomach, jejunum, ileum, transverse colon, sigmoid colon, appendix, spleen
Retroperitoneal organs	Duodenum mostly, pancreas mostly, kidneys, ascending and descending colon, aorta, IVC
Main anatomical distinction	Relative mobility versus posterior fixation
Trauma implication	Mobility favours displacement and shearing; fixation favours compression-related and retroperitoneal patterns of injury

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All intraperitoneal organs have a true free mesentery
- ✓ Stomach and spleen are intraperitoneal but supported by peritoneal ligaments
- × The duodenum and pancreas are entirely retroperitoneal
- ✓ They are mostly, not entirely, retroperitoneal
- × Retroperitoneal injury always produces immediate peritoneal signs
- ✓ Retroperitoneal injury may not produce obvious intraperitoneal signs early

Peritoneum

Parietal peritoneum	Somatic, sensitive, better-localised pain
Visceral peritoneum	Autonomic visceral afferents, poorly localised sensory response
Supracolic compartment	Upper compartment, largely beneath costal cage
Infracolic compartment	Below transverse mesocolon; divided into right and left regions
Small intestinal mesentery	Oblique root from duodenojejunal region towards ileocaecal region; contains mechanosensitive receptors
Sigmoid mesocolon	Posterior pelvic wall attachment of sigmoid colon
Greater omentum	Mobile peritoneal apron with protective, fat-storage, and mobility roles

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The greater omentum divides supracolic and infracolic compartments
- ✓ The transverse mesocolon divides supracolic from infracolic compartments

Gastrointestinal Tract

Abdominal Oesophagus

Diaphragmatic landmark	Oesophageal hiatus; surface marking near 7th costal cartilage
Gastric landmark	Cardiac orifice / gastro-oesophageal junction
Anti-reflux anatomy	LES, crural diaphragm, angle of entry, short intra-abdominal oesophagus
Injury relevance	Potential communication with upper peritoneal cavity and adjacent diaphragm, stomach, and liver

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The anti-reflux barrier is a single anatomical sphincter
- ✓ Combined mechanism: lower oesophageal sphincter, crural diaphragm, angle of entry, short intra-abdominal oesophagus
- ✗ Abdominal oesophageal injury involves only abdominal structures
- ✓ Thoracoabdominal transition point; injury may involve diaphragm, upper peritoneal cavity, stomach and liver

Caecum

Caecal position	Peritoneal floor of right iliac fossa
Relevant posterior relation	Psoas fascia / iliopsoas region
Nearby nerve relevance	Femoral nerve relation within the iliopsoas region
Appendix base	Relatively constant at the caecum
Appendix tip	Variable: retrocaecal, pelvic, subcaecal, pre-ileal, post-ileal
McBurney's point	Junction of lateral one-third and medial two-thirds of the ASIS-to-umbilicus line

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The appendix base is highly variable in position
- ✓ Base is relatively constant at the caecum; the tip is variable (retrocaecal, pelvic, etc.)
- ✗ McBurney's point is the midpoint of the right iliac fossa
- ✓ Junction of lateral one-third and medial two-thirds of the ASIS-to-umbilicus line

Colon

Ascending colon	Right-sided, relatively fixed, related to upper right abdominal and posterior structures.
Transverse colon	Crosses the upper abdomen, lies below liver and stomach, and is suspended by transverse mesocolon.
Descending colon	Left-sided, relatively fixed, related to upper left abdominal and posterior structures.
Arterial supply	IMA for hindgut colonic territory; proximal colon follows SMA supply.
Innervation	Sympathetic contribution from T10-L2 with referred visceral pain.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The entire colon is supplied by the inferior mesenteric artery
- ✓ Proximal (midgut) colon by SMA; hindgut colon by IMA
- ✗ The transverse colon is fixed like the ascending colon
- ✓ Transverse colon is mobile because it has a mesocolon
- ✗ Colonic visceral pain is sharply localised
- ✓ Visceral colonic pain is poorly localised and referred (sympathetic T10-L2)

Duodenum

Peritoneal status	Largely retroperitoneal
Levels	L1; L1-L3; L3; ascending from L3 towards L2
Key relations	Pancreas, aorta, inferior vena cava
Blood supply	Pancreaticoduodenal arteries

Jejunum and Ileum

- The jejunum and ileum are mobile intraperitoneal bowel segments suspended by the mesentery.
- Their mobility helps explain vulnerability to bowel and mesenteric injury during blunt or decelerative forces.
- Meckel's diverticulum is clinically relevant because it can ulcerate and perforate.
- Pain from jejunum and ileum may be referred to the umbilical region through sympathetic afferents entering around T9–T10.
- Their arterial supply is derived from the superior mesenteric artery as part of the midgut circulation.

EXAM TRAPS x tempting option ✓ correct answer

- ✗ The jejunum and ileum are retroperitoneal
- ✓ They are mobile intraperitoneal bowel suspended by the mesentery
- ✗ Midgut (small bowel) pain is referred to the epigastrium
- ✓ Referred to the umbilical region (sympathetic afferents around T9–T10)

Stomach

Main regions	Fundus, body, pyloric region
Pyloric role	Controls onward passage of gastric contents into the duodenum
Key relations	Diaphragm, greater omentum, spleen, transverse mesocolon
Arterial overview	Supply derived from the coeliac trunk arterial system
Parasympathetic supply	Anterior and posterior vagal trunks

EXAM TRAPS x tempting option ✓ correct answer

- ✗ The pylorus is a purely passive narrowing
- ✓ Pylorus is the regulated gastric outlet controlling passage into the duodenum

Liver and Biliary Tract

Biliary Ducts

Common hepatic duct	Union of right and left hepatic ducts.
Common bile duct	Union of common hepatic duct and cystic duct.
Main course	Supraduodenal, retroduodenal, terminal pancreatic/intramural.
Duodenal entry	Via ampulla of Vater at the major duodenal papilla in the second part of the duodenum.
Innervation	Sympathetic and parasympathetic influences on biliary function.
Referred pain	Right shoulder tip when diaphragmatic peritoneum is irritated, via the phrenic nerve.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cystic duct joins the common bile duct to form the common hepatic duct
- ✓ Cystic duct joins the common hepatic duct to form the common bile duct
- ✗ The ampulla of Vater opens into the first part of the duodenum
- ✓ Opens at the major duodenal papilla in the second part of the duodenum
- ✗ Biliary shoulder-tip pain arises from local ductal pain
- ✓ Diaphragmatic peritoneal irritation referred via the phrenic nerve

Gall Bladder

Gross parts	Fundus, body, neck
Surface marking	Near right 9th costal cartilage at lateral border of rectus abdominis
Principal relations	Liver, proximal duodenum, transverse colon
Bile storage route	Hepatic duct system → cystic duct → gall bladder
Bile emptying route	Gall bladder → cystic duct → common bile duct → duodenum
Hartmann's pouch	Outpouching at neck; common site of stone lodgement/impaction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The gall bladder fundus surface marking is midline/epigastric
- ✓ Right 9th costal cartilage at the lateral border of rectus abdominis
- ✗ Hartmann's pouch is mainly a site of gallstone formation
- ✓ A site of stone lodgement/impaction at the gall bladder neck

Liver

Surfaces	Diaphragmatic and visceral.
Named lobes	Right, left, caudate, quadrate.
Functional division	Right and left functional halves, based on major intrahepatic vascular and biliary distribution.
Surface position	Mainly beneath right costal margin and right hemidiaphragm, extending into the epigastrium.
Key diaphragmatic relations	Diaphragm, lungs and pleura.
Porta hepatis	Visceral surface gateway for key inflow structures, bile drainage, lymphatics and nerves.
IVC relation	Posterior groove; receives hepatic venous drainage.
Lobule	Central vein with peripheral portal tracts; sinusoids link inflow to venous drainage.
Blood supply	Dual inflow from hepatic artery and portal vein.
Venous return	Hepatic veins drain directly into the inferior vena cava.
Clinical anatomy	Functional vascular separation explains one-sided infarction; lymphatic drainage supports nodal spread of carcinoma.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anatomical lobes of the liver equal its functional halves
- ✓ Functional right/left halves follow vascular and biliary distribution, not the named anatomical lobes
- ✗ Hepatic veins leave the liver via the porta hepatis
- ✓ Hepatic veins drain separately and directly into the IVC posteriorly
- ✗ The liver's diaphragmatic surface has no thoracic relations
- ✓ Through the diaphragm it is closely related to the lungs and pleura

Portal Vein

Formation	Superior mesenteric vein + splenic vein
Core concept	Portal-systemic venous communications enlarge when portal pressure rises
Five sites	Oesophageal; umbilical; anorectal; retroperitoneal; diaphragmatic
Classic consequences	Oesophageal varices, periumbilical collateral veins, anorectal varices

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The portal vein is formed by the inferior mesenteric and renal veins
- ✓ Formed by the superior mesenteric vein and splenic vein
- ✗ Anorectal varices are the same as common haemorrhoids
- ✓ Related but anatomically distinct entities
- ✗ Portosystemic anastomoses are only oesophageal, umbilical and anorectal
- ✓ Five sites: also retroperitoneal and diaphragmatic

Pancreas

Functions	Exocrine secretion into duodenum; endocrine hormone release into blood
Surface projection	Deep upper abdominal organ crossing approximately L1-L2; right-sided head to leftward tail
Parts	Head, neck, body, tail
Key relations	Head within duodenal curve; neck anterior to portal vein formation; body behind stomach; tail towards splenic hilum
Arterial supply	Splenic artery branches dominate body/tail; pancreaticoduodenal arcades are important for the head
Venous return	Superior mesenteric and splenic venous pathways feeding portal drainage
Lymphatics	Regional pancreatic drainage towards coeliac and superior mesenteric pathways
Pain pathway	Sympathetic visceral afferents related to T6-T10

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The whole pancreas is supplied by the splenic artery
- ✓ Splenic branches dominate body/tail; the head depends on pancreaticoduodenal arcades
- ✗ Pancreatic veins drain directly into the systemic circulation
- ✓ Via superior mesenteric and splenic veins into portal venous return
- ✗ Pancreatic pain is referred via lower abdominal segments
- ✓ Sympathetic visceral afferents at T6-T10

Spleen

Core role	Blood filtration and immune surveillance
Surface marking	Left 9th-11th ribs; long axis near the 10th rib
Examination clue	Descends with inspiration if enlarged
Differentiating feature	Notched splenic edge and enlargement towards the right iliac fossa

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ An enlarged spleen is always felt just below the left costal margin
- ✓ Massive spleen may extend towards right iliac fossa; start palpation low, otherwise it is missed
- ✗ A left upper quadrant mass with a notch is a fixed retroperitoneal mass
- ✓ Spleen: inferomedial enlargement towards right iliac fossa, palpable notch, descends with inspiration

Kidneys, Ureters and Bladder

Kidney

Position	Retroperitoneal, high on posterior abdominal wall; right kidney commonly lower than left.
Respiration	Kidneys move inferiorly during inspiration.
Palpation	Usually not readily palpable; lower pole may be appreciated during deep inspiration in some individuals.
Relations	Diaphragm, abdominal wall muscles, pleura, peritoneum; left kidney contributes to stomach bed.
Renal fascia	Gerota's fascia helps determine spread of perinephric infection or fluid.
Arterial pattern	Large fast-flowing renal arteries; segmental intrarenal supply.
Lymph	Para-aortic nodes.
Pain referral	Visceral afferents via autonomic pathways to T10-L2.
Architecture	Cortex, medulla, nephron components and renin-secreting juxtaglomerular cells.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ A normal adult kidney is easily palpable
- ✓ Usually not palpable; deep retroperitoneal, lower pole occasionally felt on deep inspiration
- ✗ The renal arterial supply is richly collateralised
- ✓ Segmental end-artery pattern; occlusion of a segmental branch causes focal infarction
- ✗ Renal pain is sharply localised somatic pain over the kidney
- ✓ Visceral pain referred via autonomic afferents to T10-L2 dermatomes

Ureters

Surface/radiographic marking	Kidney to bladder course: renal pelvis, posterior abdominal wall, pelvic brim, bladder trigone.
Pain basis	Same broad pattern as kidney: visceral afferents with sympathetic pathways, T10-L2 referred pain.
Typical pain direction	Loin to groin; distal ureteric pain may involve groin or external genital region.
Right ureter and appendix	Appendicitis may irritate the right ureter, causing urinary symptoms; right ureteric colic may mimic appendicitis.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Urinary symptoms always indicate primary urinary tract disease
- ✓ Appendicitis can irritate the right ureter, causing urinary symptoms
- ✗ Ureteric pain is felt directly over the ureter
- ✓ Referred via visceral afferents (T10-L2): loin to groin/external genitalia

Urinary Bladder

Broad structure	Apex, base, superior surface, inferolateral surfaces.
Trigone	Between the two ureteric openings and the internal urethral orifice.
Empty bladder	Mainly pelvic; protected behind pubic symphysis.
Full bladder	Extends upwards into lower abdomen; greater trauma vulnerability.
Control of micturition	Sacral pathways, especially S2-S4, coordinated by higher centres.
Lesions above S2	Loss of normal descending voluntary control with abnormal reflex bladder function.
Pain pathway	Visceral pain transmitted centrally through pathways including the lateral spinothalamic tract.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The bladder has a fixed pelvic position
- ✓ Full bladder rises into lower abdomen, becoming vulnerable to trauma; empty bladder is pelvic
- ✗ The trigone is the whole bladder base
- ✓ Triangle between the two ureteric openings and the internal urethral orifice
- ✗ Lesions above S2 destroy the sacral micturition reflex centre
- ✓ Loss of higher descending control; sacral S2-S4 reflex intact, giving abnormal reflex bladder

Posterior Abdominal Wall

Lymph Nodes

Pre-aortic	Gut and associated digestive viscera
Para-aortic	Kidneys, suprarenals and gonads

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Kidneys and gonads drain to pre-aortic nodes
- ✓ Para-aortic nodes; pre-aortic nodes drain the gut and digestive viscera

Posterior Abdominal Nerves

Lumbar plexus	Mainly L1-L4 anterior rami, with variable T12 contribution.
Lower abdominal wall nerves	Iliohypogastric and ilioinguinal nerves.
Groin-linked nerve	Genitofemoral nerve.
Pure sensory lateral thigh nerve	Lateral cutaneous nerve of thigh.
Anterior thigh nerve	Femoral nerve, L2-L4.

Medial thigh nerve	Obturator nerve, L2-L4.
Femoral nerve relation	Emerges lateral to psoas major and descends between psoas and iliacus.
Autonomic overview	Sympathetic splanchnic pathways and parasympathetic vagal/pelvic splanchnic supply.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The femoral nerve supplies the medial thigh
- ✓ Femoral (L2-L4) supplies anterior thigh; obturator (L2-L4) supplies medial thigh
- ✗ The femoral nerve emerges medial to psoas major
- ✓ Emerges lateral to psoas major, descending between psoas and iliacus

Posterior Abdominal Vessels

The abdominal aorta and inferior vena cava run as a major arterial-venous pair on the posterior abdominal wall: the aorta lies more centrally and slightly leftward, whereas the IVC lies to its right. The arterial system is best recalled by branch groups; the venous system is best recalled by the territories returning blood to the cava.

Abdominal aorta surface extent	Approximately T12 to L4
IVC surface extent	Approximately L5 to T8, right of the aorta
Aortic branch groups	Single ventral gut; paired visceral; paired wall arteries
Single ventral branches	Coeliac trunk, SMA, IMA
Paired visceral branches	Renal, gonadal, suprarenal
Paired wall branches	Lumbar, inferior phrenic
Main caval tributaries	Common iliac, lumbar, right gonadal, renal, hepatic

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The external iliac veins unite to form the IVC
- ✓ Right and left common iliac veins form the IVC; external iliacs drain into common iliacs

Posterior Abdominal Wall Muscles

Muscle	Key relation	Main action	Innervation
Psoas major	Closely related to lumbar nerves	Hip flexion; lateral rotation of thigh	L1-L4 anterior rami
Quadratus lumborum	Between psoas major and transversus abdominis regionally	Lateral flexion of trunk	T12, L1-L4
Iliacus	Occupies iliac fossa; joins psoas major distally	Hip flexion	Femoral nerve, chiefly L2-L4

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Iliacus is supplied directly by lumbar anterior rami
- ✓ Iliacus: femoral nerve (L2-L4); psoas major: direct L1-L4 anterior rami; both flex hip

Pelvic Cavity

Bony Pelvis

Pelvic bones	Ilium, ischium, pubis, sacrum, coccyx
Hip bone formation	Ilium + ischium + pubis fuse at the acetabulum
Posterior pelvic articulation	Sacroiliac joint between sacrum and ilium
Anterior pelvic articulation	Pubic symphysis between the pubic bones
Inferior vertebral articulation	Sacroccygeal joint between sacrum and coccyx

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Each hip bone is a single bone (the ilium)
- ✓ Hip bone is three fused bones: ilium, ischium and pubis
- × The acetabulum is a separate bone
- ✓ Socket formed by fusion of ilium, ischium and pubis
- × Pelvic X-ray assessment concerns only the hip joints
- ✓ Assess pelvic ring: sacroiliac joints, pubic symphysis, obturator foramina, acetabula, sacrum

Female Reproductive System: Uterus

Anterior relation	Bladder.
Posterior relation	Rectouterine pouch of Douglas.
Lateral/inferior relation	Ureter near cervix; passes below uterine artery.
Uterine divisions	Fundus, body, cervix.
Tube divisions	Isthmus, ampulla, infundibulum.
Common ectopic site	Ampulla of uterine tube.
Blood supply	Uterine arteries in broad ligament, with ovarian and tubal anastomoses.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The ureter passes above the uterine artery
- ✓ Ureter passes below the uterine artery near the cervix (water under the bridge)

Lumbar and Sacral Plexuses

Pudendal nerve roots	S2, S3, S4.
Sciatic nerve roots	L4, L5, S1, S2, S3.
Sciatic course	Greater sciatic foramen, usually below piriformis; gluteal region; posterior thigh.
Sciatic branches	Muscular branches to posterior thigh; terminal tibial and common peroneal nerves.
Tibial nerve	Central in popliteal fossa; posterior leg compartment; continues behind medial malleolus to sole.
Common peroneal nerve	Follows biceps femoris, winds around fibular neck, divides into superficial and deep peroneal nerves.
Classic injury pattern	Common peroneal injury at fibular neck causes foot drop through loss of dorsiflexion.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Pudendal nerve roots are L4-S3
- ✓ Pudendal S2-S4; sciatic L4-S3
- ✗ Foot drop is due to tibial nerve injury
- ✓ Common peroneal (or deep peroneal) injury, classically at fibular neck; loss of dorsiflexion

Male Internal Genitalia: Prostate

Size	Approximately walnut-sized; about 3 × 4 × 2 cm and around 20 g.
Position	Inferior to bladder neck, superior to pelvic floor.
Urethral relation	Prostatic urethra passes through the gland from the bladder neck.
Posterior relation	Rectum; enables digital rectal examination.
BPH anatomy	Periurethral enlargement narrows the urethral channel.
Malignancy anatomy	Posterior/peripheral disease may be palpable as hard irregularity or nodularity.
Lymph drainage	Pelvic nodes, mainly internal iliac, also obturator, external iliac and sacral.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Prostatic enlargement is unrelated to urethral obstruction
- ✓ Prostate surrounds proximal urethra; periurethral BPH narrows the channel
- ✗ A smooth enlarged prostate suggests malignancy
- ✓ Smooth enlargement suggests BPH; hard, irregular, nodular (posterior/peripheral) suggests malignancy
- ✗ The prostate drains to superficial inguinal nodes
- ✓ Pelvic nodes, mainly internal iliac (also obturator, external iliac, sacral); scrotum drains superficial inguinal

Male Urogenital Region

Male urethral length	Approximately 20 cm in the adult.
Urethral divisions	Prostatic, membranous and spongy (penile).
Widest part	Prostatic urethra.
Most fixed clinically important segment	Membranous urethra.
Penile urethral course	Within corpus spongiosum.
Penis cross-section	Paired dorsal corpora cavernosa; ventral corpus spongiosum with urethra.
Scrotal lymph drainage	Superficial inguinal nodes.
Scrotal/penile segmental innervation	Scrotum: L1 and S2-S3; penis: especially S2.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The testes drain to superficial inguinal nodes
- ✓ Testes drain to para-aortic nodes; scrotum drains to superficial inguinal
- ✗ The penile urethra lies between the corpora cavernosa
- ✓ Lies ventrally within the corpus spongiosum
- ✗ The prostatic urethra is the segment most vulnerable in trauma
- ✓ Membranous urethra: short, narrow and relatively fixed

Ovary

Location	Lateral pelvis, near uterine tube and pelvic side wall.
Pain radiation	May radiate to medial thigh via relationship to obturator nerve territory.
Blood supply	Ovarian artery from the abdominal aorta.
Lymph drainage	Mainly para-aortic nodes; possible inguinal lymphadenopathy.
Innervation	Visceral afferents with autonomic pathways explain ovarian pain patterns.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The ovary drains first to pelvic or inguinal nodes
- ✓ Mainly para-aortic nodes
- ✗ The ovarian artery arises from the internal iliac artery
- ✓ Arises directly from the abdominal aorta
- ✗ Medial thigh pain is always musculoskeletal
- ✓ Pelvic/ovarian pathology may irritate obturator nerve territory, referring pain to medial thigh

Pelvic Floor

Structural concept	A muscular sheet forming the inferior support of the pelvic cavity
Main actions	Postural tonus and contractile tonus
Postural tonus	Baseline resting support
Contractile tonus	Active reinforcement during increased intra-abdominal pressure

Pelvic Stability: Joints and Ligaments

Main stability principle	Pelvic joints are reinforced by strong ligaments; movement is limited.
Sacroiliac stability	Strong ligamentous support stabilises load transfer through the pelvis.
Sacrotuberous ligament	Sacrum/coccyx to ischial tuberosity.
Sacrospinous ligament	Sacrum/coccyx to ischial spine.
Iliolumbar ligament	L5 transverse process to ilium; stabilises lumbosacral junction.
Sacrococcygeal joint	Limited movement; ligamentous stability.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The sacrotuberous ligament attaches to the ischial spine
- ✓ Sacrotuberous → ischial tuberosity; sacrospinous → ischial spine
- ✗ Pelvic stability is mainly provided by muscles
- ✓ Largely ligamentous, especially sacroiliac and lumbosacral (iliolumbar) regions

Rectum and Anus

Rectal origin	Continuation of sigmoid colon where the mesocolon ends, around S3
DRE anterior relation	Male: prostate; female: cervix
DRE posterior relation	Sacrum and coccyx
DRE lateral relation	Ischiorectal fossa and pelvic side walls
Anorectal junction	Transition to sphincter mechanism supported by puborectalis
Rectovesical fascia	Relevant to anterior spread of rectal carcinoma in the male pelvis

Sympathetic supply	Hypogastric plexus; L1-L2
Parasympathetic supply	Pelvic splanchnic nerves; S2-S4
Anal canal length	Approximately 4 cm in the adult
Lymph drainage	Internal iliac and superficial inguinal nodes
Anal reflex	Tests perianal sensation and sacral S2-S4 pathways

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The rectum begins at the anal canal
- ✓ Begins where the sigmoid mesocolon ends, around S3
- ✗ Rectal pain is sharp and well localised
- ✓ Rectal pain is visceral and poorly localised; anal skin pain is sharp somatic

Vagina

Type of structure	Fibromuscular canal
Extent	Vestibule to cervix
Approximate adult size	About 7-9 cm long
Anterior relations	Urethra and bladder
Posterior relations	Anal canal and rectum
Female urethra	Opening lies in the vaginal vestibule, anterior to the vaginal orifice

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cervix is assessed per rectum
- ✓ Cervix palpated through the vagina; prostate assessed per rectum in males

ANATOMY · TOPIC 5 OF 7

Head & Neck

Scalp

Arterial Supply of Scalp

Supply pattern	Rich anastomosing arterial network
Source systems	External carotid and internal carotid branches
Clinical implication	Scalp wounds may bleed profusely
Anatomical reason	Deep dermal/connective tissue attachment holds arteries open

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The scalp is supplied by isolated end arteries
- ✓ Rich anastomotic network from external and internal carotid branches
- ✗ Scalp wounds bleed profusely only because of vessel number
- ✓ Dense connective tissue tethers vessels open, preventing retraction; plus rich anastomoses

Innervation of Scalp

- The posterior scalp is supplied by the occipital nerves.
- The auriculotemporal nerve supplies the temporal scalp anterior and superior to the ear.
- The zygomaticotemporal nerve supplies the anterior temporal region around the temple.
- Auriculotemporal nerve is derived from CN V3; zygomaticotemporal nerve is derived from CN V2.
- Scalp sensory supply should not be confused with facial nerve motor supply to occipitofrontalis.

Occipitofrontalis

Muscle type	Muscle of scalp and facial expression
Main parts	Frontal belly, occipital belly, epicranial aponeurosis
Nerve supply	Facial nerve (CN VII)
Main actions	Raises eyebrows and wrinkles forehead
Exam relevance	Forehead movement helps assess facial nerve function

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Occipitofrontalis closes the eye
- ✓ Raises eyebrows and wrinkles forehead; orbicularis oculi closes the eye
- × The frontal belly has a major bony origin
- ✓ Attached to skin/subcutaneous tissue anteriorly and epicranial aponeurosis posteriorly
- × Occipitofrontalis is supplied by the trigeminal nerve
- ✓ Facial nerve (CN VII); trigeminal supplies facial sensation and mastication muscles

Temporal Fossa

Boundaries	Temporal lines and zygomatic arch.
Arch components	Zygomatic bone + temporal bone processes.
Temporalis nerve supply	Deep temporal branches of V3.
Temporalis action	Elevation and retraction of mandible.

Venous Drainage of Scalp

Basic drainage pattern	Veins accompany arteries
Important posterior communication	Posterior auricular vein region to mastoid vessels
Intracranial connection	Mastoid emissary vessels communicate with the sigmoid sinus
Clinical implication	Potential spread of infection from scalp to intracranial venous sinuses

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Scalp veins have no intracranial communication
- ✓ Mastoid emissary vessels connect posterior scalp veins to the sigmoid sinus, allowing intracranial spread of infection

Face

Arterial Supply of the Face

Main central facial artery	Facial artery
Facial artery origin	External carotid artery
Facial artery course	Tortuous course towards the medial angle of the eye
Terminal continuation	Angular artery
Superficial temporal artery origin	External carotid artery
Superficial temporal surface marking	Anterior to the ear, crossing the zygomatic arch into the temporal scalp

 **EXAM TRAPS** × tempting option ✓ correct answer

- × The facial artery is a branch of the internal carotid
- ✓ Branch of the external carotid artery
- × The facial artery runs a straight course
- ✓ Tortuous course, an adaptation to facial movement
- × The superficial temporal pulse is felt behind the ear
- ✓ Anterior to the ear, over the zygomatic arch

Eyelids

Which muscle closes the eye?	Orbicularis oculi
Which nerve supplies orbicularis oculi?	Facial nerve (CN VII)
Where is orbicularis oculi positioned?	Around the eyelids, over the frontal and zygomatic bones
What muscle elevates the upper lid?	Levator palpebrae superioris
What muscle raises the eyebrows?	Occipitofrontalis (frontal belly)

 **EXAM TRAPS** × tempting option ✓ correct answer

- × Orbicularis oculi elevates the upper eyelid
- ✓ Orbicularis oculi closes the eye; levator palpebrae superioris elevates the lid
- × Orbicularis oculi is supplied by the trigeminal nerve
- ✓ Facial nerve (CN VII), as for all facial expression muscles

Facial Lymph Drainage

Main drainage groups	Submental, submandibular, preauricular/parotid
Submental clue	Central lower face/chin region
Submandibular clue	Much of anterior face
Preauricular/parotid clue	Lateral face and adjacent temporal/periorbital regions
Final pathway	Drainage continues to deep cervical nodes

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Facial lymph drains only to submental and submandibular nodes
- ✓ Also preauricular/parotid nodes, all continuing to deep cervical nodes
- ✗ Facial lymphatic territories have rigid boundaries
- ✓ Drainage territories overlap; only the broad pattern is reliable

Facial Muscle Innervation Overview

Motor supply	Facial nerve (CN VII) supplies all facial expression muscles.
Functional arrangement	Muscles are grouped around facial orifices as sphincters and dilators.
Sphincter effect	Closes or constricts an opening.
Dilator effect	Widens, retracts or changes the shape of an opening.
Common distinction	CN VII controls movement; CN V supplies most facial sensation.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A facial nerve lesion causes loss of facial skin sensation
- ✓ Causes facial expression muscle weakness; sensation is trigeminal (CN V)

Facial Nerve in the Facial Region

Skull exit	Stylomastoid foramen
Site of terminal branching	Parotid gland
Five named branches	Temporal, zygomatic, buccal, marginal mandibular, cervical
Eye closure	Orbicularis oculi via zygomatic and temporal branches
Cheek and lip control	Buccinator and orbicularis oris via buccal branch
Lower lip depression	Marginal mandibular branch
Neck skin tension	Platysma via cervical branch

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The facial nerve supplies sensation to the face
- ✓ Facial nerve is motor to facial muscles; facial sensation is trigeminal
- ✗ Terminal facial nerve branches provide parotid secretomotor supply
- ✓ Parotid secretomotor: CN IX → lesser petrosal → otic ganglion; facial branches merely pass through
- ✗ A marginal mandibular branch lesion causes complete facial paralysis
- ✓ Causes lower lip asymmetry (loss of lower lip depression) only
- ✗ Forehead sparing indicates a terminal branch (lower motor neurone) lesion
- ✓ Forehead sparing indicates upper motor neurone lesion; branch lesions cause regional LMN weakness

Lips and Cheeks

Main lip muscle	Orbicularis oris
Main cheek muscle	Buccinator
Shared innervation	Facial nerve (CN VII)
Buccinator action	Compresses cheek; keeps food between teeth during mastication
Modiolus	Fibromuscular convergence point lateral to the angle of mouth

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Buccinator is a trigeminal muscle of mastication
- ✓ Muscle of facial expression supplied by facial nerve (buccal branch); only assists chewing mechanically
- ✗ Orbicularis oris is a simple circular sphincter
- ✓ Composite circumoral muscle integrating fibres from surrounding muscles, especially buccinator

Sensory Supply of the Face

Division	Named branches to remember	Core territory
V1 ophthalmic	Supraorbital, supratrochlear, infratrochlear, external nasal, lacrimal	Upper face, forehead, nose and peri-orbital region
V2 maxillary	Infraorbital, zygomaticofacial, zygomaticotemporal	Midface, cheek, lower eyelid and upper lip region
V3 mandibular	Mental, buccal, auriculotemporal	Lower face, cheek and auriculotemporal region

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Facial sensation is supplied by the facial nerve
- ✓ Trigeminal nerve; facial nerve supplies muscles of facial expression
- ✗ The mental, buccal and auriculotemporal nerves are motor
- ✓ Sensory branches of V3; V3 is mixed overall, V1 and V2 purely sensory
- ✗ V1 herpes zoster carries no risk to the eye
- ✓ V1 territory includes eye; ophthalmic zoster may involve the eye

Venous Drainage of the Face

Principal superficial vein	Facial vein
Key superior continuation	Angular vein near the medial canthus
Orbital communication	Via ophthalmic veins
Intracranial connection	Cavernous sinus
Important infection route	Upper lip or cheek → angular vein → ophthalmic veins → cavernous sinus

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The facial vein drains directly into the cavernous sinus
- ✓ Via angular vein (medial canthus) → ophthalmic veins → cavernous sinus
- ✗ The danger-area communication is at the angle of the mouth
- ✓ Medial canthus, where the angular vein connects with the ophthalmic veins
- ✗ Facial infection spreads to the cavernous sinus via arteries
- ✓ Spread is venous: angular and ophthalmic veins

Parotid Region

Infratemporal Fossa

Location	Deep lateral skull-base space beneath the skull base, between pharynx and mandible
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Muscles	Medial and lateral pterygoids
Venous structure	Pterygoid venous plexus
Nerve	Mandibular nerve, V3

Mandibular Nerve

Cranial exit	Foramen ovale
Regional course	Middle cranial fossa to lateral pterygoid region
Main division	Anterior and posterior trunks
Auriculotemporal nerve	Scalp, ear and TMJ
Inferior alveolar nerve	Lower teeth, chin and lower lip
Lingual nerve	General sensation from anterior two-thirds of tongue
Chorda tympani (CN VII, joins lingual nerve)	Taste from anterior two-thirds of tongue; secretomotor to submandibular and sublingual glands

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ The lingual nerve carries taste from the anterior tongue
- ✓ Lingual (V3): general sensation; chorda tympani (CN VII): taste, anterior two-thirds
- ✗ The mandibular nerve exits via foramen rotundum
- ✓ Foramen ovale; foramen rotundum transmits the maxillary nerve (V2)

Masseter

- The masseter is a superficial muscle of mastication on the lateral aspect of the mandibular ramus.
- It attaches broadly from the zygomatic arch to the mandible.
- Its nerve supply is the masseteric branch of the mandibular nerve (V3).
- Its principal action is elevation of the mandible, producing jaw closure.

Maxillary Artery

Parent vessel	External carotid artery
Region	Parotid/deep facial region, continuing into the infratemporal fossa area
Supply overview	Local bone, ear, tympanum, nose, and palate

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ The maxillary artery is a branch of CN V2
- ✓ Maxillary artery: branch of external carotid; maxillary nerve is CN V2

Parotid Gland

Location	Anterior to ear; posterior to mandibular ramus.
Capsule	Strong parotid sheath; contained swelling is painful.
Embedded structures	Facial nerve branches, external carotid artery, retromandibular vein.
Duct course	Across masseter, then through buccinator.
Duct opening	Opposite upper second molar tooth.
Secretomotor pathway	Glossopharyngeal nerve → lesser petrosal nerve → otic ganglion → parotid gland.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The parotid duct opens in the floor of the mouth
- ✓ Opposite upper second molar; submandibular duct opens in floor of mouth
- ✗ The facial nerve provides secretomotor supply to the parotid
- ✓ CN IX via lesser petrosal and otic ganglion; facial nerve only passes through

Pterygoid Venous Plexus

Region	Infratemporal fossa
Nature	Venous plexus rather than a single vein
Procedure risk	Potential injury during local dental anaesthetics
Main drainage	Via maxillary veins to the retromandibular vein
Key connections	Deep facial vein, inferior ophthalmic veins, cavernous sinus
Clinical significance	Potential route for spread of facial or dental infection to deeper venous pathways

Pterygoids

Lateral pterygoid	Opening the mouth
Medial pterygoid	Elevates mandible; side-to-side chewing

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The lateral pterygoid closes the jaw
- ✓ Lateral pterygoid opens the mouth; medial pterygoid elevates mandible

Temporomandibular Joint

TMJ Structure and Movements

Joint type	Synovial condylar articulation
Articular bones	Mandibular head and squamous temporal bone
Stability	Closed position is more stable than open position
Named ligaments	Lateral temporomandibular and sphenomandibular ligaments
Opening	Passive opening plus active opening via lateral pterygoid and digastric contribution
Closing	Masseter, temporalis and medial pterygoid elevate the mandible
Grinding	Lateral deviation from coordinated asymmetric movement of the paired TMJs

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The TMJ is a simple hinge joint
- ✓ Synovial condylar joint combining hinge movement with gliding translation
- ✗ Lateral pterygoid is a jaw-closing muscle
- ✓ Masseter, temporalis, medial pterygoid close; lateral pterygoid and digastric assist opening
- ✗ Grinding is repeated opening and closing of the jaw
- ✓ Lateral deviation from coordinated asymmetric movement of paired TMJs

Orbit and Eye

Bony Orbit

Main concept	Bony socket protecting the globe
Seven orbital bones	Frontal, zygomatic, maxillary, lacrimal, ethmoid, sphenoid, palatine
Palpable rim	Mainly frontal, zygomatic and maxillary bones

Conjunctiva

Tissue type	Mucous membrane
Surface layer	Non-keratinised stratified epithelium
Supporting layer	Vascular connective tissue / substantia propria
Main sensory nerve division	Trigeminal nerve, mainly CN V1
Additional sensory contribution	Infraorbital nerve (CN V2) to lower palpebral conjunctiva

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The conjunctiva is a purely fibrous structure
- ✓ Mucous membrane: non-keratinised stratified epithelium on vascular connective tissue
- × Conjunctival sensation is supplied by the facial nerve
- ✓ Trigeminal nerve, mainly V1
- × All conjunctival sensation is via V1
- ✓ Lower palpebral conjunctiva has V2 (infraorbital) contribution

Eye Movement and Palsies

CN III palsy	Divergent squint, ptosis, dilated pupil, "down and out" eye
CN IV palsy	Vertical diplopia, worst looking down and inward
CN VI palsy	Horizontal diplopia with convergent squint
Superior rectus paralysis	Diplopia on looking up

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × CN IV palsy causes horizontal diplopia
- ✓ CN IV: vertical diplopia; CN VI: horizontal diplopia with failure of abduction
- × CN III palsy does not cause ptosis
- ✓ CN III supplies levator palpebrae superioris, so ptosis is part of the pattern

Eyelids

Orbital septum	Fibrous sheet that blends into the tarsal plates.
Tarsal plates	Dense connective tissue framework of the eyelids.
Meibomian glands	Tarsal glands within the tarsal plates; open near the eyelid margin.
Motor supply	Facial nerve for closure; oculomotor nerve for upper lid elevation.
Sensory supply	Upper lid mainly V1; lower lid mainly V2.

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × The tarsal plates are cartilage
- ✓ Dense connective tissue

Lacrimal Apparatus

Main components	Lacrimal gland, canaliculi, lacrimal sac, nasolacrimal duct
Gland location	Lateral orbital roof
Sac location	Medial canthus
Sac function	Receives tears from canaliculi
Duct function	Drains tears from sac into the nose
Nasal opening	Inferior meatus

Optic Nerve (CN II)

Route from orbit	Through the sphenoidal optic canal
Structure accompanying it	Ophthalmic artery
Composition	Outgrowth of central nervous system white matter
Subarachnoid space	Extends around the optic nerve and communicates with the intracranial subarachnoid space
Papilloedema rationale	Raised intracranial pressure is transmitted along the optic nerve sheath
Blood supply	Anterior cerebral, ophthalmic and central retinal arteries

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × The optic nerve is a peripheral cranial nerve without meninges
- ✓ CNS tract with meninges and subarachnoid space; raised ICP transmits, causing papilloedema
- × CN II passes through the superior orbital fissure
- ✓ Optic canal, with the ophthalmic artery

Orbital Blood Supply

Orbital muscles	Supplied by branches of the ophthalmic arterial system
Lacrimal gland	Receives local orbital arterial supply from the ophthalmic system
Eye	Supplied by the ophthalmic arterial system, including branches to ocular tissues

Orbital Muscles

Arrangement	Cone of orbital muscles around the globe
Recti muscles	Bony posterior attachment provides a stable fixed point
CN III muscles	Superior rectus, medial rectus, inferior rectus, inferior oblique
CN IV muscle	Superior oblique
CN VI muscle	Lateral rectus
Oblique muscle torsion	Superior oblique intorts; inferior oblique extorts

EXAM TRAPS × tempting option ✓ correct answer

- × All extraocular muscles are supplied by CN III
- ✓ Lateral rectus: CN VI; superior oblique: CN IV
- × Superior oblique extorts the eye
- ✓ Superior oblique intorts; inferior oblique extorts
- × The recti have no role in stabilising the globe
- ✓ Bony posterior attachment provides a fixed point that stabilises the globe

Orbital Venous and Lymph Drainage

Main named venous communication	Superior ophthalmic vein to cavernous sinus
Additional venous channel	Inferior ophthalmic vein
Key clinical implication	Potential spread from orbital or facial region to cavernous sinus
Lymph drainage route	Preauricular/parotid groups, then deep cervical nodes

EXAM TRAPS × tempting option ✓ correct answer

- × Orbital veins do not communicate with the cranial cavity
- ✓ Superior ophthalmic vein communicates with the cavernous sinus
- × Orbital lymph drains directly into the cavernous sinus
- ✓ Preauricular/parotid nodes, then deep cervical nodes; cavernous sinus link is venous

Structural Anatomy of the Eye

Fibrous coat	Sclera and cornea.
Vascular coat	Choroid, ciliary body and iris.
Nervous coat	Retina.
Corneal reflex	Afferent CN V1; efferent CN VII.
Pupil control	Sympathetic dilator activity balanced against parasympathetic constrictor activity.
Normal fundus landmarks	Optic disc, retinal vessels, macula and fovea.
Retinal blood supply	Central retinal artery for inner retina; choroidal circulation supports outer retina.
Refractive media	Cornea, aqueous humour, lens and vitreous; suspensory ligament links lens to ciliary body.

EXAM TRAPS × tempting option ✓ correct answer

- × The corneal reflex efferent limb is CN V1
- ✓ Afferent CN V1; efferent CN VII (eyelid closure)
- × The optic disc contains photoreceptors
- ✓ No photoreceptors, so it is the normal blind spot
- × Pupil size is controlled by a single pathway
- ✓ Balance of sympathetic dilator and parasympathetic constrictor activity

Ear

Auditory Tube and Mastoid Antrum

Auditory tube	Connection between middle ear region and nasopharynx.
Main function	Pressure equalisation across the tympanic membrane.
Mastoid antrum	Air-containing space in mastoid temporal bone.
Mastoid air cells	Air-filled temporal bone spaces related to the middle ear cleft.
Key clinical anatomy	Potential spread of sepsis via venous drainage to the sigmoid sinus.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The auditory tube connects the pinna to the tympanic membrane
- ✓ Auditory tube: middle ear to nasopharynx; external acoustic meatus: pinna to tympanic membrane
- ✗ Mastoid air cells have no route to intracranial venous sinuses
- ✓ Within temporal bone; venous drainage to sigmoid sinus allows spread of sepsis

External Ear

Pinna	Folded cartilaginous structure
Prime pinna innervation	Great auricular and auriculotemporal nerves
Additional auricular innervation	Facial and lesser occipital nerve contributions
External acoustic meatus	Adult length approximately 3 cm; conducts sound to tympanic membrane
Tympanic membrane	Functional sound-vibration membrane; handle of malleus attached

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The pinna is supplied by a single nerve
- ✓ Mainly great auricular and auriculotemporal, with facial and lesser occipital contributions
- ✗ The tympanic membrane is one of the ossicles
- ✓ Membrane vibrates; handle of malleus is attached to it

Internal Ear

Cochlea	Hearing
Semicircular canals	Kinetic balance
Saccule and utricle	Static balance

Middle Ear

Location	Air-filled middle ear space within the petrous temporal bone
Lateral boundary	Tympanic membrane
Medial functional relation	Transfers vibration towards the inner ear
Main function	Converts airborne vibrations to liquid-borne pulses
Ossicles	Malleus, incus and stapes

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The tympanic membrane lies between middle and inner ear
- ✓ Boundary between external and middle ear
- ✗ The middle ear is fluid-filled
- ✓ Air-filled; inner ear contains the fluid-filled sensory structures

Structural Overview of the Ear

External ear	Lateral collecting region that conducts sound to the tympanic membrane.
Tympanic membrane	Boundary between external and middle ear; vibrates in response to sound.
Middle ear	Air-filled transmitting region containing the ossicles.
Ossicles	Malleus, incus and stapes; transmit vibration towards the inner ear.
Inner ear	Deep sensory region for hearing and balance.

Nose and Paranasal Sinuses

External Nose

Main sensory nerve family	Trigeminal nerve
Upper/dorsal nose	Mainly ophthalmic division (V1)
Lower lateral nose/ala	Mainly maxillary division (V2)
Arterial supply	Branches of ophthalmic and facial arteries

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Little's area lies on the external nose
- ✓ Anterior nasal septum within the nasal cavity
- ✗ The ala of the nose is supplied by V1
- ✓ Ala/lower lateral nose mainly V2; upper/dorsal nose mainly V1
- ✗ The external nose is supplied only by external carotid branches
- ✓ Both ophthalmic (internal carotid) and facial (external carotid) branches contribute

Function of Nasal Cavity

The nasal cavity is adapted to warm, humidify and filter inspired air. Its ciliated epithelial lining moves mucus and trapped particles posteriorly, while its moist vascular mucosa conditions air before it reaches the lower airway.

Nasal Cavity

Conchae	Inferior, middle and superior turbinates on the lateral wall.
Inferior turbinate	Common anatomical basis for nasal swelling and obstruction.
Nasolacrimal duct	Drains tears into the inferior meatus.
Sinus drainage	Maxillary sinus and ethmoidal air cells open into the nasal cavity.
Septal blood supply	Includes vessels forming Little's area / Kiesselbach's plexus.
Nerve supply	Mainly trigeminal sensory supply from V1 and V2; olfactory fibres high in the cavity.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The nasolacrimal duct opens into the middle meatus
- ✓ Inferior meatus
- ✗ Little's area is supplied only by external carotid branches
- ✓ Both internal carotid (ophthalmic) and external carotid (facial/maxillary) contributions

Paranasal Sinuses

Sinus groups	Maxillary, ethmoidal, frontal and sphenoidal.
Core concept	Paired air-filled spaces communicating with the nasal cavity.
Development	Appearance becomes more reliable from approximately 6-7 years onwards.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Asymmetrical frontal sinuses are abnormal
- ✓ Normal asymmetry is common
- ✗ Poorly developed sinuses in a young child are pathological
- ✓ Normal; sinuses become reliably visible from about 6-7 years

Mouth, Hard Palate and Tongue

Floor of the Mouth

Main muscular floor	Mylohyoid
Mobile oral component	Tongue
Duct ending in floor	Submandibular duct
Salivary gland in floor	Sublingual gland
Motor nerve to tongue	Hypoglossal nerve (CN XII)
General sensory nerve anterior tongue/floor	Lingual nerve (V3)
Posterior tongue sensory/taste nerve	Glossopharyngeal nerve (CN IX)
Key artery	Lingual artery

Hard Palate

Anterior component	Palatine processes of maxillae
Posterior component	Horizontal plates of palatine bones
Main blood supply	Greater palatine artery
Sensory supply	Greater palatine and nasopalatine nerves via CN V2
Lymph drainage	Mainly to upper deep cervical nodes, with submandibular/retropharyngeal pathways contributing

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The hard palate is muscular, like the soft palate
- ✓ Hard palate is bony; the soft palate is muscular
- ✗ Hard palate sensation is supplied by the mandibular nerve (V3)
- ✓ Branches of V2 (greater palatine and nasopalatine nerves)
- ✗ The hard palate is supplied mainly by the sphenopalatine artery
- ✓ Greater palatine artery is the key artery of the hard palate

Mucous Membrane and Gingivae

Upper gingivae	V2 via superior alveolar, greater palatine and nasopalatine branches
Lower gingivae	V3 via inferior alveolar-related, mental, buccal and lingual branches
Buccal mucosa	Buccal nerve of V3
Hard palate mucosa	Greater palatine and nasopalatine nerves of V2
Floor of mouth / lingual mucosa	Lingual nerve of V3
Posterior tongue / oropharyngeal mucosa	Glossopharyngeal nerve (CN IX)

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Buccal mucosa sensation is from the buccal branch of the facial nerve
- ✓ Buccal nerve of V3 (sensory); the facial nerve's buccal branch is motor to facial expression muscles
- ✗ The lingual nerve carries taste from the anterior tongue
- ✓ Lingual nerve carries general sensation; taste fibres travel with chorda tympani
- ✗ Lower oral mucosa and gingivae are mainly supplied by V2
- ✓ Upper oral mucosa and gingivae are mainly V2; lower are mainly V3

Teeth

Adult dentition	32 permanent teeth
Dental formula per quadrant	2 incisors, 1 canine, 2 premolars, 3 molars
Upper tooth innervation	Superior alveolar branches of V2
Lower tooth innervation	Inferior alveolar nerve from V3
Upper anaesthesia	Local infiltration near tooth apex is often effective
Lower posterior anaesthesia	Inferior alveolar nerve block near mandibular foramen
Pain basis	Pulp and periodontal tissues are innervated; enamel is insensate

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Upper teeth are supplied by V3 and lower teeth by V2
- ✓ Upper teeth are V2 (superior alveolar); lower teeth are V3 (inferior alveolar)
- ✗ Mandibular posterior teeth are anaesthetised by simple local infiltration
- ✓ Usually need an inferior alveolar nerve block near the mandibular foramen
- ✗ Enamel is the pain-sensitive layer of the tooth
- ✓ Enamel is insensate; dental pain arises from dentine, pulp and periodontal innervation

Tongue

Main division	Anterior two-thirds and posterior one-third
Surface landmark	Sulcus terminalis, with foramen caecum at its apex
Anterior general sensation	Lingual nerve (V3, general somatic afferent)
Anterior taste	Chorda tympani fibres from facial nerve (CN VII), carried with lingual nerve
Posterior sensation and taste	Glossopharyngeal nerve (CN IX)
Lymph drainage principle	Drainage to cervical nodes with clinically important crossover across the midline

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The lingual nerve is the taste nerve of the anterior tongue
- ✓ Lingual nerve carries general sensation; anterior taste is chorda tympani (CN VII)
- ✗ Tongue lymph drains only to ipsilateral cervical nodes
- ✓ Crossover drainage across the midline can produce bilateral cervical node involvement

Pharynx

Gag Reflex

Sensory limb	Glossopharyngeal nerve (CN IX)
Motor limb	Vagus nerve (CN X)
Main anatomical region	Oropharyngeal mucosa and pharyngeal/palatal musculature

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ CN X is the afferent limb of the gag reflex
- ✓ CN IX is the afferent (sensory) limb; CN X is the efferent (motor) limb

Interior of Pharynx

Adenoids	Pharyngeal tonsil in the nasopharynx
Auditory tube opening	Lateral wall of the nasopharynx
Palatine tonsils	Oropharynx, within the tonsillar fossae
Tonsillar bed	Vascular region; facial artery contribution and deep lateral relation of internal carotid artery
External palatine vein	Close to tonsillar bed; relevant to local haemorrhage
Tonsillar lymph drainage	Deep cervical group, especially jugulodigastric node
Valleculae	Between tongue base and epiglottis

EXAM TRAPS × tempting option ✓ correct answer

- × The adenoids lie in the oropharynx
- ✓ Nasopharynx
- × The palatine tonsil is the adenoid
- ✓ Palatine tonsils lie in oropharyngeal tonsillar fossae; the pharyngeal tonsil is the adenoid
- × Tonsillar lymph drains mainly to the submental node
- ✓ Deep cervical group, especially the jugulodigastric node
- × The valleculae lie within the larynx below the epiglottis
- ✓ Between the tongue base and the epiglottis

Laryngeal Region of Pharynx

Region	Inferior pharyngeal region posterior to the larynx
Main opening	Laryngeal inlet
Lateral recesses	Piriform fossae
Core function	Separation of airway and alimentary pathway during swallowing

EXAM TRAPS × tempting option ✓ correct answer

- × The laryngeal inlet is the opening between the vocal cords
- ✓ Inlet is the pharyngeal opening into the larynx; vocal cords lie deeper within the larynx
- × The piriform fossae are part of the oral cavity
- ✓ Laryngopharyngeal region (lateral recesses beside the laryngeal inlet)

Muscular Pharynx Overview

Extent	Skull base to oesophagus at C6.
Posterior relation	Prevertebral fascia.
Infection spread	Can spread posteriorly through deep cervical fascial planes.
Muscular action	Three constrictor groups act in concert during swallowing.
Lymph drainage	Deep cervical lymph node groups.
Motor supply	Pharyngeal plexus of vagus, glossopharyngeal and sympathetic fibres.
Sensory supply	Nasal portion V2; oral portion CN IX; laryngeal portion laryngeal nerves.

EXAM TRAPS × tempting option ✓ correct answer

- × The pharynx continues as the oesophagus at C4
- ✓ C6

Soft Palate

Uvula	Midline mucoglandular projection from posterior soft palate
Motor supply	Pharyngeal plexus (CN X), except tensor veli palatini (CN V3)
Secretomotor supply	Pterygopalatine ganglion
Sensory supply	Maxillary nerve (CN V2)

EXAM TRAPS × tempting option ✓ correct answer

- × Soft palate muscles are supplied by the maxillary nerve (V2)
- ✓ V2 is sensory; motor is pharyngeal plexus (CN X), except tensor veli palatini (V3)
- × The uvula is a separate cartilaginous structure
- ✓ Midline mucoglandular projection from the posterior soft palate

Larynx

Laryngeal Innervation

Main motor nerve	Recurrent laryngeal nerve
Main target	Intrinsic laryngeal muscles
Key exception	Cricothyroid: external branch of superior laryngeal nerve
Partial paralysis	Hoarseness, weak voice/cough; possible impaired abduction
Complete unilateral paralysis	Immobile ipsilateral vocal fold with hoarseness and weak cough
Complete bilateral paralysis	Potential airway compromise and major impairment of phonation/protection
Extrinsic muscles	Elevators and depressors of the larynx during swallowing

EXAM TRAPS × tempting option ✓ correct answer

- × All intrinsic laryngeal muscles are supplied by the recurrent laryngeal nerve
- ✓ Except cricothyroid: external branch of the superior laryngeal nerve
- × Extrinsic laryngeal muscles move the vocal folds
- ✓ Intrinsic muscles move the vocal folds; extrinsic muscles move the larynx as a whole in swallowing

Laryngeal Muscles

Main division	Intrinsic and extrinsic laryngeal muscle groups
Intrinsic muscle role	Alter laryngeal inlet and move vocal folds
Extrinsic muscle role	Elevate or depress the larynx as a whole
Core functions	Phonation, sphincteric protection, coughing, breath-holding during straining

Location

Superior relationship	Inferior to the hyoid bone
Inferior relationship	Blends with the trachea
Vertebral level of transition	C6

Skeletal Framework

Framework components	Cartilages, joints, membranes and ligaments
Single cartilages	Thyroid, cricoid and epiglottic
Paired cartilages	Arytenoid cartilages
Key joints	Cricothyroid and cricoarytenoid
Key membrane	Cricothyroid membrane / conus elasticus
Surface marking	Between thyroid and cricoid cartilages

Clinical relevance	Emergency airway access via surgical cricothyroidotomy
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⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The cricothyroid membrane lies between tracheal rings
- ✓ Between the thyroid and cricoid cartilages
- × The arytenoid cartilage is single and sits on the thyroid cartilage
- ✓ Arytenoids are paired and sit on the cricoid cartilage

General Topography of the Neck

Sternomastoid (Sternocleidomastoid)

Lower attachments	Manubrium and medial clavicle.
Upper attachment	Mastoid process and lateral superior nuchal line.
Motor nerve supply	Spinal accessory nerve (CN XI).
Cervical contribution	Especially C2-C3 fibres.
Unilateral action	Contralateral head rotation with ipsilateral lateral flexion.
Bilateral action	Neck flexion.
Clinical test	Resisted head rotation; palpate the opposite sternocleidomastoid.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The left sternocleidomastoid turns the face to the left
- ✓ Left sternocleidomastoid turns the face to the right (contralateral rotation)
- × Sternocleidomastoid's principal motor supply is C2-C3
- ✓ Spinal accessory nerve (CN XI); C2-C3 are associated cervical fibres

Anterior and Posterior Triangles of Neck

Primary landmark	Sternocleidomastoid
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Muscles and Fascia Overview

Postvertebral muscles	Extensor musculature behind the vertebral column.
Prevertebral muscles	Flexor musculature in front of the vertebral column.
Prevertebral fascia	Fascial plane associated with the prevertebral compartment; neck viscera lie anterior to it.
Pretracheal fascia	Encloses the thyroid gland.
Investing layer	Encloses sternomastoid and trapezius.
Deep cervical fascia components	Investing layer, pretracheal fascia, prevertebral fascia, carotid sheath.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Deep cervical fascia is a single undifferentiated layer
- ✓ Four components: investing layer, pretracheal fascia, prevertebral fascia, carotid sheath
- × The neck viscera lie behind the prevertebral fascia
- ✓ Anterior to it; prevertebral fascia relates to the vertebral column and prevertebral muscles

Suprahyoid and Infrahyoid Muscles

Suprahyoids	Effectors of swallowing
Infrahyoids	Laryngeal depressors
Hyoid bone	Mobile functional anchor for these muscle groups

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Infrahyoid muscles elevate the hyoid-larynx complex in swallowing
- ✓ Suprahyoids elevate in swallowing; infrahyoids depress and stabilise

Tissue Spaces of the Neck

Key spaces	Prevertebral, retropharyngeal, parapharyngeal and submandibular spaces
Core anatomical concept	Infection spreads along fascial planes rather than through solid tissue at random
Retropharyngeal relevance	Posterior to pharynx; infection may spread inferiorly and threaten airway
Parapharyngeal relevance	Lateral to pharynx; may communicate with adjacent deep neck spaces
Submandibular relevance	Floor-of-mouth/dental infection may spread here and cause Ludwig's angina
Ludwig's angina	Submandibular/sublingual infection elevates and displaces tongue, risking airway obstruction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The retropharyngeal space lies directly on the vertebral column
- ✓ Prevertebral space is deeper, on the vertebral column; retropharyngeal is closer to the pharyngeal wall
- ✗ Ludwig's angina is primarily a lymph node infection
- ✓ Spreading infection of submandibular and floor-of-mouth fascial spaces

Neck Vasculature and Nerves

Accessory Nerve (CN XI)

Cranial nerve	Accessory nerve (CN XI)
Skull exit	Jugular foramen
Root description	Cranial root and spinal root
Cranial root	Joins vagus; associated with nucleus ambiguus
Spinal root territory	Sternomastoid and trapezius

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cranial root of CN XI supplies trapezius and sternomastoid
- ✓ Spinal root (spinal accessory component); the cranial root joins the vagus
- ✗ CN XI exits the skull through the hypoglossal canal
- ✓ Jugular foramen; the hypoglossal canal transmits CN XII
- ✗ Sternomastoid weakness impairs shoulder shrug
- ✓ Sternomastoid weakness impairs turning head to the opposite side; trapezius weakness impairs shrug and scapular elevation

Carotid Sheath Contents

Main contents	Carotid artery, internal jugular vein, vagus nerve
Arterial component below bifurcation	Common carotid artery
Arterial component above bifurcation	Internal carotid artery
Internal jugular vein position	Lateral
Carotid artery position	Medial
Vagus nerve position	Posterior between artery and vein

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The external carotid artery is a core carotid sheath content above the bifurcation
- ✓ Internal carotid artery above the bifurcation; common carotid below
- × The vagus lies anteriorly within the carotid sheath
- ✓ Posteriorly, between the carotid artery and internal jugular vein
- × The sympathetic trunk lies within the carotid sheath
- ✓ Posterior to the sheath; the vagus is the nerve inside

Glossopharyngeal Nerve (CN IX)

Skull exit	Jugular foramen
Middle ear	Sensory supply
Parotid gland	Secretomotor pathway
Carotid sinus	Baroreceptor innervation
Pharynx	Sensory supply; gag reflex afferent limb
Tonsils	Sensory supply
Tongue	Taste from posterior one-third

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × CN X is the afferent limb of the gag reflex
- ✓ CN IX is afferent; CN X is the principal efferent limb
- × Parotid secretomotor supply comes from the facial nerve
- ✓ CN IX is the preganglionic source; CN VII supplies submandibular, sublingual and lacrimal secretion
- × Taste from the posterior third of the tongue is via chorda tympani
- ✓ CN IX; anterior two-thirds taste is chorda tympani (CN VII)

Hypoglossal Nerve (CN XII)

Cranial nerve	Hypoglossal nerve, CN XII
Skull exit	Hypoglossal canal
Main function	Motor supply to tongue muscles
Intrinsic muscles	Alter tongue shape
Extrinsic muscles	Move tongue position as a whole
Important exception	Palatoglossus is supplied by the vagus nerve, not CN XII

EXAM TRAPS × tempting option ✓ correct answer

- ✗ CN XII carries taste and general sensation from the tongue
- ✓ CN XII is motor only to tongue muscles; sensation and taste use other cranial nerves

Maxillary Nerve (CN V2)

Nerve	Maxillary nerve (CN V2)
Division	Second division of trigeminal nerve
Function	General sensory
Exit from skull	Foramen rotundum
Bone	Sphenoid
Named facial branches	Infraorbital, zygomaticofacial, zygomaticotemporal
Clinical localisation	Sensory disturbance in the midface

EXAM TRAPS × tempting option ✓ correct answer

- ✗ V2 exits the skull through the foramen ovale
- ✓ Foramen rotundum; V3 exits via foramen ovale
- ✗ The maxillary nerve has a motor component
- ✓ V2 is purely sensory
- ✗ V2 supplies forehead and upper eyelid skin
- ✓ V2 is the midface; forehead/upper eyelid is V1, lower jaw is V3

Pterygopalatine Fossa

Key content	Pterygopalatine ganglion
Sensory role	General sensation from nose and palate
Secretomotor role	Parasympathetic supply to nasal and palatine mucosal glands
Sympathetic role	Vasomotor supply to nasal and palatal mucosa

EXAM TRAPS × tempting option ✓ correct answer

- ✗ All fibre types synapse in the pterygopalatine ganglion
- ✓ Only parasympathetic secretomotor fibres synapse there

Vagus Nerve (CN X)

Skull exit	Jugular foramen
Accessory relationship	Cranial root of CN XI arises from nucleus ambiguus and joins the vagus
Ear	Sensory
Pharynx	Motor and sensory
Hypopharynx	Sensory
Larynx	Via superior laryngeal and recurrent laryngeal nerves
Cardiac plexus	Autonomic parasympathetic contribution

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The vagus nerve is purely parasympathetic
- ✓ In the neck it also carries motor fibres to pharyngeal and laryngeal structures
- ✗ CN IX, X and XI exit through separate foramina
- ✓ All exit via the jugular foramen; skull-base lesions give combined lower cranial nerve signs

Root of the Neck

Root of Neck Structures

Scalenus anterior	C3-C6 to first rib; C5-C6 innervation; synergistic neck stabiliser.
Phrenic nerve	Descends on the anterior surface of scalenus anterior; close to the lung apex, with the vagus nearby.
Right recurrent laryngeal nerve	Originates from vagus and loops around the right subclavian artery.
Jugulo-omohyoid node	Deep cervical lymph node involved in tongue drainage.
Subclavian vein	Anterior to scalenus anterior; accessed via infraclavicular approach.
Subclavian artery	Surface marking above/behind midpoint of clavicle; compressible against first rib.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The subclavian vein lies posterior to scalenus anterior
- ✓ Vein is anterior to scalenus anterior; artery is posterior
- ✗ Both recurrent laryngeal nerves loop around the subclavian arteries
- ✓ Right loops round right subclavian; left loops round the aortic arch in the thorax

Cervical Sympathetic Trunk

Cervical Sympathetic Ganglia

Cervical ganglia	Superior, middle and inferior ganglia are the cervical components of the sympathetic trunk.
Somatic branches	Grey rami from the cervical ganglia distribute sympathetic fibres to C1-C8 spinal nerves.
Visceral branches	Cervical sympathetic cardiac branches contribute to the cardiac plexuses.
Vascular branches	Fibres follow blood vessels, especially carotid-related pathways, to reach head and eye targets.
Dilator pupillae	Receives sympathetic fibres; loss causes miosis.
Horner's syndrome	Partial ptosis, miosis, anhidrosis and apparent enophthalmos after sympathetic interruption.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Horner's syndrome causes complete ptosis
- ✓ Partial ptosis from superior tarsal muscle loss; complete ptosis (levator palpebrae superioris) suggests CN III
- ✗ Miosis in Horner's is due to excess parasympathetic stimulation
- ✓ Loss of sympathetic supply to dilator pupillae
- ✗ Anhidrosis in Horner's syndrome is a parasympathetic sign
- ✓ Sympathetic sign: loss of sudomotor supply to facial sweat glands

Thyroid

Thyroid Structure

Gross structure	Right and left lobes joined by an isthmus
Isthmus attachment	Anterior to the 2nd and 3rd tracheal rings
Lateral relations	Carotid sheath and sternomastoid
Medial relations	Trachea and oesophagus
Posterior relation	Parathyroid glands
Recurrent laryngeal nerve	Ascends in tracheo-oesophageal groove, close to posterior thyroid and inferior thyroid artery
Blood supply	Superior and inferior thyroid arteries; venous drainage via superior, middle and inferior thyroid veins
Main haemorrhage concern	Expanding neck haematoma and airway compression
Lymph drainage	Prelaryngeal, pretracheal and paratracheal nodes to deep cervical nodes

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The recurrent laryngeal nerve lies lateral to the thyroid lobe
- ✓ Tracheo-oesophageal groove, close to the posterior thyroid and inferior thyroid artery
- ✗ Thyroid bleeding is dangerous mainly because of blood loss
- ✓ Expanding neck haematoma causing airway compression

Trachea (Neck)

Cervical Trachea

Patency	Maintained by C-shaped hyaline cartilage rings and posterior trachealis muscle.
Upper landmark	Lower border of cricoid cartilage, approximately C6.
Anterior relations	Infrahyoid muscles, pretracheal fascia, thyroid isthmus and inferior thyroid veins.
Posterior relation	Oesophagus.
Lateral relations	Thyroid lobes, carotid sheaths further lateral, recurrent laryngeal nerves in tracheo-oesophageal grooves.
Procedure landmark	Midline access below cricoid cartilage through upper tracheal rings.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Tracheostomy is performed through the cricothyroid membrane
- ✓ Cricothyroidotomy enters the cricothyroid membrane; tracheostomy enters trachea below the cricoid
- ✗ No vascular structure lies anterior to the upper cervical trachea
- ✓ Thyroid isthmus and inferior thyroid veins are anterior relations at risk in tracheal access
- ✗ The cervical trachea has no important posterior relation
- ✓ Oesophagus lies posteriorly; risk of posterior wall injury or false passage
- ✗ The recurrent laryngeal nerves run within the thyroid gland
- ✓ In the tracheo-oesophageal grooves beside the trachea and oesophagus

Oesophagus (Neck)

Cervical Oesophagus

Upper limit	Pharyngoesophageal junction at approximately C6, behind the cricoid cartilage.
Lower limit	Thoracic inlet, where it continues as the thoracic oesophagus.
Anterior relation	Trachea.
Posterior relation	Prevertebral fascia, prevertebral muscles and cervical vertebrae.
Lateral relations	Thyroid lobes and carotid sheaths.
Key nerve relation	Recurrent laryngeal nerves in the tracheo-oesophageal grooves.
Key narrowing	Cricopharyngeal/pharyngoesophageal narrowing at the upper end.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cervical oesophagus lies anterior to the trachea
- ✓ Posterior to the trachea
- ✗ Lower neck pathology cannot affect the voice
- ✓ Recurrent laryngeal nerves run in the tracheo-oesophageal grooves, so thyroid/lower neck pathology may cause hoarseness

Vertebral Column

Atlas and Axis

C1 atlas	No centrum; no vertebral body
C2 axis	Dens/odontoid process and bifid spinous process
Atlanto-occipital joint	Flexion and extension; nodding
Atlanto-axial joint	Rotation around the dens
Cruciform ligament	Prime stabiliser of the dens
Ligament damage	Instability with risk of upper cervical cord compression

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Head rotation occurs mainly at the atlanto-occipital joint
- ✓ Rotation is mainly C1/C2 (atlanto-axial); nodding is mainly C0/C1
- ✗ The alar ligaments are the prime stabiliser of the dens
- ✓ Cruciform ligament: key restraint preventing dangerous dens displacement

Intervertebral Discs and Ligaments

Outer disc component	Annulus fibrosus.
Central disc component	Nucleus pulposus.
Anterior reinforcement	Anterior longitudinal ligament: broad, strong, resists extension.
Posterior reinforcement	Posterior longitudinal ligament: within vertebral canal; narrower, especially inferiorly.
Common disc protrusion direction	Posterior or posterolateral.
Typical nerve-root principle	Affected root is often named one level below the disc space in the lumbar region.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Disc level and nerve-root level are always the same
- ✓ Lumbar affected root is often one level below the disc space (traversing root)
- × The nucleus pulposus is the fibrous outer ring of the disc
- ✓ Annulus fibrosus is the fibrous ring; nucleus pulposus is the gelatinous centre
- × Ligamenta flava connect adjacent vertebral bodies
- ✓ They connect laminae; longitudinal ligaments run on vertebral bodies

Muscles of the Vertebral Column

Flexion	Predominantly rectus abdominis
Rotation	Obliques assist trunk rotation
Posterior extensor mass	Erector spinae
Erector spinae overview	Iliocostalis, longissimus and spinalis
Innervation	Segmental posterior (dorsal) rami of spinal nerves

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Erector spinae is the main flexor of the vertebral column
- ✓ Flexion is predominantly rectus abdominis; erector spinae is the posterior extensor mass
- × Erector spinae is a single short muscle at one level
- ✓ Longitudinal muscle group (iliocostalis, longissimus, spinalis) running along the spine
- × Intrinsic back muscles are supplied by anterior rami
- ✓ Segmental posterior (dorsal) rami of spinal nerves

Vertebral Canal

Anterior boundary	Vertebral bodies and posterior longitudinal ligament
Posterior boundary	Laminae and ligamenta flava
Lateral boundaries	Pedicles and intervertebral foramina
Contents	Meninges, spinal cord and spinal nerve roots
Meninges	Dura, arachnoid and pia
Epidural space	Between bony canal and dura
Below conus	Cauda equina and filum terminale
Lumbar puncture	L3/4 or L4/5; "give" at ligamentum flavum then dura

EXAM TRAPS × tempting option ✓ correct answer

- × CSF lies in the epidural space
- ✓ Subarachnoid space; epidural space is outside the dura
- × Lumbar puncture is done at L1/L2
- ✓ Cord ends about L1/L2 in adults, so use L3/4 or L4/5

Vertebral Column Movements

Flexion	Forward bending
Extension	Backward bending
Lateral flexion	Side-bending to right or left
Rotation	Predominantly thoracic column

EXAM TRAPS × tempting option ✓ correct answer

- × Vertebral rotation is evenly distributed along the column
- ✓ Predominantly thoracic
- × Lateral flexion is twisting of the spine
- ✓ Lateral flexion is side-bending; twisting is rotation

Vertebral Structure

Body	Anterior, weight-bearing component
Pedicle	Connects body to posterior arch
Lamina	Forms posterior arch and contributes to vertebral canal boundary
Articular processes	Superior and inferior processes forming joints with adjacent vertebrae
Regional count	Cervical 7, thoracic 12, lumbar 5, sacral 5 fused, coccygeal variable

EXAM TRAPS × tempting option ✓ correct answer

- × Laminae arise directly from the vertebral body
- ✓ Pedicles arise from the body; laminae form the posterior arch

ANATOMY · TOPIC 6 OF 7

Central Nervous System

Cerebral Hemispheres

Basal Nuclei (Ganglia)

Where are the basal nuclei?	Within the lateral forebrain
What type of tissue are they?	Internal grey matter cell groupings
What do they control?	Skeletal muscle movement at a supraspinal level
What is the Parkinson's disease link?	Loss of dopaminergic neurones in the substantia nigra

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The basal nuclei form part of the cortical surface
- ✓ Deep internal grey matter masses in the lateral forebrain
- × The basal nuclei directly innervate skeletal muscle
- ✓ They exert supraspinal motor control, not lower motor neurone supply

Corpus Callosum

Structure type	White matter commissural fibre tract
Main role	Connects symmetrical parts of the cerebral hemispheres
Functional concept	Allows interhemispheric communication

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The corpus callosum is a projection fibre pathway
- ✓ Commissural tract; the internal capsule is the projection pathway

Cortical Areas

Area	Site	Function
Broca's	Dominant frontal lobe	Motor speech
Wernicke's	Dominant temporal lobe	Sensory speech / comprehension
Auditory cortex	Superior temporal gyrus	Hearing and cortical sound processing
Visual cortex	Occipital lobe, calcarine sulcus region	Vision

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Broca's aphasia causes fluent speech with impaired comprehension
- ✓ That is Wernicke's; Broca's is non-fluent production difficulty
- × Language areas are always in the left hemisphere
- ✓ In the dominant hemisphere, not the left in every individual
- × Primary visual cortex lesions cause an eye movement palsy
- ✓ They cause visual field deficits
- × A unilateral auditory cortex lesion causes complete ipsilateral deafness
- ✓ Rarely; auditory input has bilateral cortical representation

Cortical Structure

Outer cerebral covering	Grey matter cortex
Internal grey matter	Basal nuclei and thalamus
Surface folds	Gyri
Surface grooves	Sulci
Frontal lobe	Anterior to central sulcus; above lateral sulcus
Parietal lobe	Posterior to central sulcus; above lateral sulcus
Temporal lobe	Below lateral sulcus
Occipital lobe	Posterior to the parieto-occipital sulcus

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ The basal nuclei and thalamus form the outer cerebral covering
- ✓ All are grey matter, but only the cortex forms the outer covering

White Matter

White matter	Myelinated fibres linking cortical and deeper structures
Commissural fibres	Connect the two hemispheres
Arcuate / association fibres	Connect regions within the same hemisphere
Projection fibres	Connect cortex to lower centres
Internal capsule	Compact mass of projection fibres
Clinical significance	Haemorrhage or thrombosis may interrupt many fibres because they are densely packed

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ Commissural fibres connect cortex with lower centres
- ✓ Commissural fibres cross between hemispheres; projection fibres connect cortex to lower centres

Thalamus

- The thalamus consists of grouped grey matter nuclei rather than a single homogeneous structure.
- It lies deep within the forebrain as a wedge-shaped structure around the third ventricle.
- Its central role is to relay sensory impulses to the cerebral cortex.

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ The thalamus forms the floor of the third ventricle
- ✓ Hypothalamus lies below the thalamus, forms the floor, and has autonomic/endocrine roles
- ✗ The thalamus is the final site of conscious sensory interpretation
- ✓ It relays sensory impulses to the cortex, where interpretation occurs

Brainstem

Brainstem Nuclei (Overview)

Eye movement nuclei	CN III, IV and VI nuclei control extraocular movement; CN III is also associated with pupil constriction through parasympathetic fibres.
Facial and trigeminal nuclei	CN V links to facial sensation and mastication; CN VII links to facial expression.
Hearing and balance	CN VIII nuclei process cochlear and vestibular information.
Swallowing, voice and pharyngeal function	CN IX and X nuclei contribute to pharyngeal and laryngeal sensory and motor control.
Accessory and hypoglossal function	CN XI supplies sternocleidomastoid and trapezius; CN XII supplies tongue muscles.

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- ✗ A cranial nerve nuclear lesion is an upper motor neurone lesion
- ✓ Lower motor neurone lesion; usually ipsilateral weakness of supplied structure

Medulla Oblongata

Anatomical identity	Lowest brainstem segment; upward continuation of the spinal cord.
Blood supply	PICA plus branches of the vertebral and basilar arteries.
Medial medullary syndrome	Anterior spinal artery branch territory; contralateral weakness/sensory tract involvement with ipsilateral hypoglossal signs.
Lateral medullary syndrome	PICA territory; vestibular, swallowing, crossed sensory, Horner's and cerebellar signs.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Lateral medullary syndrome is anterior spinal artery territory
- ✓ Lateral is PICA territory; medial is anterior spinal artery branch territory
- × Medullary lesions give ipsilateral long tract signs
- ✓ Ipsilateral cranial nerve signs with contralateral long tract signs (crossed pattern)

Midbrain

Part of brainstem	Midbrain + pons + medulla form the brainstem.
Position	Superior brainstem, between diencephalon and pons.
Tentorial landmark	Passes through the tentorial notch (aperture).
Arterial supply	Posterior cerebral and superior cerebellar arteries.
Parkinson's disease link	Loss of dopaminergic neurones in the substantia nigra.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The midbrain is supplied by anterior circulation branches
- ✓ Posterior cerebral and superior cerebellar arteries

Pons

Position	Middle part of brainstem, between midbrain and medulla
Key nuclei	Motor trigeminal, abducent, vestibulocochlear
Clinical prediction	Pontine haemorrhage may cause jaw motor, eye movement, auditory or vestibular signs
Blood supply	Pontine branches from the basilar artery

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × CN VI palsy causes ptosis and a down-and-out eye
- ✓ CN VI prevents abduction only; ptosis, pupil involvement and down-and-out is CN III

Cerebellum

Location	Posterior cranial fossa
Core role	Coordination of posture, trunk stability and smooth movement
Lesion pattern	Disturbed balance and movement without paralysis

Blood supply	PICA, AICA and superior cerebellar artery
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⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Cerebellar lesions cause paralysis
- ✓ Incoordination and balance disturbance without paralysis

Ventricles

Ventricular System

Main source of CSF	Choroid plexuses, especially in the lateral ventricles
Choroid plexus composition	Capillaries, pia and ependymal cells
Lateral ventricle shape	C-shaped cavity with body and anterior, inferior and posterior horns
Lateral-to-third connection	Interventricular foramen of Monro
Third ventricle	Midline slit-like sagittal cavity; hypothalamus forms its floor and lower lateral walls
Fourth ventricle	Related to pons and upper medulla
Imaging principle	Third, fourth ventricles and aqueduct are symmetrical; lateral ventricles may be asymmetrical

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × The lateral ventricles must be perfectly symmetrical
- ✓ Mild asymmetry can be normal; third, fourth ventricles and aqueduct are symmetrical
- × CSF is produced equally by all ventricles
- ✓ Mostly from the lateral ventricular choroid plexuses
- × The hypothalamus is the cavity of the third ventricle
- ✓ Hypothalamus forms the floor and lower lateral walls; it is not the cavity

Cerebrospinal Fluid

CSF

Where is CSF produced?	Choroid plexuses
How much CSF is present?	Approximately 130 ml
Where is most CSF found?	Subarachnoid space
How is CSF resorbed?	Via arachnoid granulations into venous circulation
Why is CSF rhinorrhoea important?	It suggests a skull base fracture creating communication with nasal tissues
What are the main roles of CSF?	Buoyancy/cushioning, ionic stability and waste removal

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Most CSF volume is in the ventricles
- ✓ Subarachnoid space
- × CSF resorption is an active process
- ✓ Passive and pressure-dependent, via arachnoid granulations into venous sinuses
- × Clear nasal discharge after head trauma is simple rhinorrhoea
- ✓ CSF rhinorrhoea: suggests base of skull fracture linking CSF spaces and nasal tissues

Cerebral Blood Supply

Anterior Cerebral Artery

Origin	Terminal branch of the internal carotid artery.
Midline connection	Right and left ACAs communicate via the anterior communicating artery.
Main cortical territory	Medial surface of cerebral hemisphere.
Key functional area	Leg and foot sensorimotor cortex.
Occlusion effect	Contralateral lower limb weakness and sensory impairment.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × ACA occlusion mainly affects face and upper limb
- ✓ ACA is leg and foot; MCA is mainly face and upper limb
- × The circle of Willis prevents infarction after ACA occlusion
- ✓ Collateral routes exist, but occlusion can still cause infarction

Cerebral Venous Drainage

Where are the cerebral draining veins situated?	Superficially, in the subarachnoid space.
What is their broad role?	Drain venous blood from the cerebral hemispheres towards dural venous channels.

Internal Carotid Artery

Entry into skull	Carotid canal
Important intracranial relation	Cavernous sinus region
Orbital branch	Ophthalmic artery
Circle of Willis connection	Posterior communicating artery
Terminal cerebral branches	Anterior cerebral artery and middle cerebral artery
Clinical principle	End-artery occlusion can cause territorial infarction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The posterior cerebral artery is a terminal branch of the internal carotid
- ✓ Usually terminal from the basilar artery; ICA terminates as ACA and MCA

Middle Cerebral Artery

Vessel	Middle cerebral artery, arising from the internal carotid system.
Embolitic risk	High susceptibility to embolism.
Sensorimotor supply	Contralateral face and upper limb areas.
Auditory area	Supplied by MCA branches.
Speech areas	Broca's and Wernicke's areas in the dominant hemisphere.

EXAM TRAPS × tempting option ✓ correct answer

- × MCA stroke mainly affects the leg
- ✓ Contralateral face and upper limb (leg is ACA)
- × Dysphasia follows MCA stroke of either hemisphere
- ✓ Requires dominant-hemisphere involvement, most commonly left

Overview of Cerebral Vasculature

Cerebral vasculature is best approached by linking arterial anatomy to function. The internal carotid and vertebral systems supply the brain and communicate through the arterial circle of Willis. Because cerebral branches act largely as end arteries, occlusion produces infarction in predictable territories: middle cerebral artery for lateral hemisphere and speech areas, anterior cerebral artery for medial leg/foot territories, and posterior cerebral artery for visual cortex.

EXAM TRAPS × tempting option ✓ correct answer

- × The circle of Willis reliably prevents infarction in acute occlusion
- ✓ Collateral flow is variable and often inadequate
- × ACA lesions affect face and upper limb more than leg
- ✓ MCA: face and upper limb more; ACA: leg more
- × Berry aneurysms are unrelated to the circle of Willis
- ✓ Berry aneurysms arise on the circle of Willis and cause subarachnoid haemorrhage

Posterior Cerebral Artery

What gives rise to the posterior cerebral artery?	The basilar artery.
What is its most important cortical territory?	The occipital visual cortex.
What is the classic visual deficit?	Contralateral homonymous hemianopia.
Why can macular vision be spared?	Collateral supply to the occipital pole, classically from middle cerebral artery territory.

EXAM TRAPS × tempting option ✓ correct answer

- × PCA occlusion causes face and arm weakness
- ✓ PCA supplies visual cortex (contralateral homonymous hemianopia); face/arm and speech are MCA
- × Macular sparing reflects partial recovery of vision
- ✓ Collateral supply to the occipital pole, classically from MCA territory

Spinal Cord Anatomy

Clinical Effects of Cord Division

Complete transection	Everything lost below the lesion; spinal shock first, then upper motor neurone signs.
Brown-Sequard syndrome	Same side: motor and proprioception loss. Opposite side: pain and temperature loss.
Central cord syndrome	Arms weaker than legs; sacral sensation relatively spared.
Anterior spinal artery syndrome	Motor and pain-temperature lost; dorsal column modalities preserved.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Spinal shock is a permanent lower motor neurone state
- ✓ Temporary; later signs below the lesion are upper motor neurone
- × Anterior spinal artery syndrome abolishes proprioception and vibration
- ✓ Dorsal column modalities (fine touch, vibration, proprioception) are relatively preserved

Cord Blood Supply

Anterior spinal artery	Single vessel supplying anterior two-thirds of cord
Posterior spinal arteries	Paired vessels supplying posterior one-third of cord
Anterior territory	Anterior horn cells, corticospinal and spinothalamic pathways
Posterior territory	Posterior columns: fine touch, vibration and proprioception
Key clinical pattern	Anterior spinal artery syndrome: motor and pain-temperature loss with posterior column sparing

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The posterior spinal arteries supply the anterior two-thirds of the cord
- ✓ Single anterior spinal artery: anterior two-thirds; paired posterior spinal arteries: posterior one-third
- × Anterior spinal artery syndrome abolishes posterior column modalities
- ✓ Posterior columns are spared; they are supplied by the posterior spinal arteries

Cord Enlargements

Cervical enlargement	C3-T1; brachial plexus
Lumbosacral enlargement	L1-S3 cord segments (T9-L1 vertebral level); lumbar and sacral plexuses
Reason for enlargement	Increased neuronal representation for limb innervation

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The listed enlargement levels are vertebral levels
- ✓ They are spinal cord segment levels; e.g. lumbosacral enlargement L1-S3 segments lies at T9-L1 vertebrae
- × The cervical enlargement starts at C5, as the brachial plexus is C5-T1
- ✓ Cervical enlargement spans C3-T1 cord segments
- × The lumbosacral enlargement supplies only the lumbar plexus
- ✓ It is associated with both the lumbar and sacral plexuses

Extent of the Spinal Cord

Upper continuity	Medulla oblongata at the foramen magnum
Lower end of cord	Conus medullaris
Conus at birth	L3
Conus by age 21	L1 or L2
Anatomical rationale	Vertebral column grows more than the spinal cord

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The adult conus medullaris lies at L3
- ✓ L1 or L2 by age 21; L3 is the approximate level at birth
- ✗ The conus rises because the spinal cord actively migrates upwards
- ✓ Differential growth: the vertebral column grows more than the spinal cord

Internal Anatomy of the Cord

Grey matter	Central H-shaped region; anterior horn motor, posterior horn sensory.
White matter	Peripheral fibre tracts.
Dorsal columns	Fine touch, vibration and proprioception; ipsilateral ascent; cross in medulla.
Lateral corticospinal tract	Voluntary motor pathway; fibres cross in medulla.
Spinothalamic tract	Pain and temperature; crosses within 1-2 spinal cord levels.
Spinocerebellar tracts	Proprioceptive input to cerebellum for coordination.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ All sensory tracts decussate at the same level
- ✓ Dorsal columns cross in the medulla; spinothalamic fibres cross within 1-2 segments of entry
- ✗ The anterior horn of grey matter is sensory
- ✓ Anterior horn is motor; posterior horn is sensory
- ✗ Lateral corticospinal fibres cross within the spinal cord
- ✓ They have already crossed in the medulla before descending in the cord

Projectional Tracts

Afferent transmission	Sensory information travels towards higher centres
Efferent transmission	Motor commands travel from higher centres towards spinal motor neurones
Decussation	Crossing of fibres across the midline
Clinical significance	The side of the deficit depends on whether fibres have crossed before the lesion

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Dorsal column and spinothalamic fibres cross at the same level
- ✓ Dorsal columns cross in the medulla; spinothalamic fibres cross within one to two spinal segments
- ✗ A spinal cord lesion causes contralateral motor signs below the lesion
- ✓ Ipsilateral motor signs: lateral corticospinal fibres have already crossed in the medulla
- ✗ A tract's function alone predicts the side of the clinical deficit
- ✓ The crossing pattern relative to the lesion predicts the side of the deficit

Spinal Nerve Roots

Initial emergence	Rootlets in the subarachnoid space
Root formation	Rootlets amalgamate into anterior and posterior roots
Mixed spinal nerve	Forms when anterior and posterior roots unite after leaving the dural sleeve
Below L1	Descending roots form the cauda equina
Lower roots	Steeper descent to reach their intervertebral foramina
Disc herniation pattern	Traversing root affected: commonly the root one level below

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Anterior and posterior roots are already mixed spinal nerves
- ✓ Roots remain separate motor and sensory components; the mixed nerve forms after they unite beyond the dural sleeve
- × Below the conus medullaris the canal contains spinal cord
- ✓ It contains cauda equina roots (below L1)
- × A lumbar disc prolapse compresses the exiting root at that disc level
- ✓ It usually affects the traversing root, one level below

Visual Fields and Pathways

Visual Pathway

Retina	Bipolar cells relay to ganglion cells; ganglion axons form the optic nerve
Optic nerve	Carries all visual fibres from one eye; lesion causes monocular blindness
Optic chiasma	Nasal retinal fibres cross; lesion causes bitemporal hemianopia
Optic tract	Carries ipsilateral temporal and contralateral nasal retinal fibres; lesion causes contralateral homonymous hemianopia
Lateral geniculate body / optic radiation	Relay and projection to occipital cortex; lesions cause contralateral homonymous field loss
Visual cortex	Calcarine region of occipital lobe; PCA infarction may cause macular sparing

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The nasal retina receives the nasal visual field
- ✓ Nasal retina receives the temporal field; temporal retina receives the nasal field
- × Post-chiasmal lesions cause monocular or heteronymous field loss
- ✓ Homonymous loss: optic tract, LGB, optic radiation and cortex lesions affect the same field side in both eyes
- × Bitemporal hemianopia localises to the optic tract or radiation
- ✓ Optic chiasma: the crossing nasal retinal fibres are involved
- × Macular sparing occurs with any optic pathway lesion
- ✓ Typical of posterior cortical lesions, especially PCA infarction, with preserved occipital pole supply

ANATOMY · TOPIC 7 OF 7

Cranial Nerve Lesions

Hypoglossal Nerve (CN XII)

Tongue deviates towards lesion	LMN hypoglossal palsy
Tongue wasting and fasciculation	LMN denervation of ipsilateral tongue muscles
Tongue deviates away from lesion	UMN hypoglossal weakness
Skull base or hypoglossal canal disease	Potential CN XII involvement

EXAM TRAPS × tempting option ✓ correct answer

- × In LMN hypoglossal palsy the tongue deviates away from the lesion
- ✓ LMN deviates towards the lesion; UMN deviates away
- × Tongue wasting occurs in all CN XII lesions, including UMN
- ✓ Wasting and fasciculation are lower motor neurone signs only
- × Skull-base pathology affects CN XII mainly at the jugular foramen
- ✓ The hypoglossal canal is the key skull-base site for CN XII involvement

Accessory Nerve (Spinal Part) (CN XI)

Nerve	Spinal accessory nerve, CN XI
Muscles affected	Trapezius and sternocleidomastoid
Trapezius lesion effect	Drooping shoulder; difficulty elevating shoulder/arm above horizontal
Sternocleidomastoid lesion effect	Weakness turning head to the opposite side
Common causes	Posterior triangle neck surgery and trauma
Sensory deficit	None expected from an isolated spinal accessory nerve lesion

EXAM TRAPS × tempting option ✓ correct answer

- × A right CN XI lesion weakens head turning to the right
- ✓ Weakens turning to the left: sternocleidomastoid turns the head to the opposite side
- × Inability to raise the arm above horizontal after CN XI injury indicates deltoid palsy
- ✓ Loss of trapezius scapular rotation and shoulder girdle support, not primary deltoid lesion

Facial Nerve (CN VII)

UMN facial palsy	Contralateral lower face weakness; forehead spared.
LMN facial palsy	Ipsilateral whole-face weakness; forehead affected.
Most common LMN cause	Bell's palsy.
Course	Pons → stylomastoid foramen → parotid gland → five terminal branches.
Parotid relevance	Facial nerve trunk and branches are vulnerable in parotid tumour, trauma and surgery.
Five branches	Temporal, zygomatic, buccal, marginal mandibular, cervical.

EXAM TRAPS × tempting option ✓ correct answer

- × Bell's palsy spares the forehead
- ✓ Bell's palsy is LMN, so the ipsilateral forehead is involved
- × UMN facial palsy causes ipsilateral whole-face weakness
- ✓ UMN: contralateral lower face, forehead spared; LMN: ipsilateral whole face
- × Facial sensation is supplied by the facial nerve
- ✓ Trigeminal nerve supplies facial sensation; facial nerve supplies muscles of facial expression

Glossopharyngeal Nerve (CN IX)

Main sensory territory	Oropharynx, tonsils and posterior one-third of tongue.
Taste territory	Posterior one-third of tongue.
Gag reflex role	Afferent limb.
Common causes	Posterior fossa tumours, skull base lesions and jugular foramen pathology.
Key exam distinction	Absent gag may reflect CN IX afferent failure or CN X efferent failure; interpret with other signs.

EXAM TRAPS × tempting option ✓ correct answer

- × The vagus provides both limbs of the gag reflex
- ✓ CN IX is the afferent limb; CN X is the efferent limb
- × Taste from the posterior one-third of the tongue is via the facial nerve
- ✓ Glossopharyngeal nerve (CN IX)
- × Combined CN IX, X and XI signs suggest separate unrelated lesions
- ✓ Suggests a jugular foramen lesion

Ocular Palsies (CN III, IV, VI)

Lesion	Typical eye position / diplopia	Pupil	Common causes
CN III palsy	"Down and out"; diplopia with impaired adduction, elevation and depression; ptosis	May be dilated/fixed if compressive; often spared in microvascular palsy	Posterior communicating artery aneurysm, herniation, diabetes, hypertension
CN IV palsy	Vertical diplopia, worst looking down and inward; compensatory head tilt away from lesion	Normal	Trauma
CN VI palsy	Convergent squint; horizontal diplopia, especially on lateral gaze	Normal	Raised intracranial pressure, trauma, vascular disease

EXAM TRAPS × tempting option ✓ correct answer

- × CN IV palsy causes horizontal diplopia with failure of abduction
- ✓ That is CN VI; CN IV gives vertical diplopia, worst looking down and in
- × Compressive third nerve palsy is typically pupil-sparing
- ✓ Pupil involvement (dilated) is the red flag for compression; microvascular palsy often spares the pupil
- × Painful pupil-involving CN III palsy is classically a posterior cerebral artery aneurysm
- ✓ Posterior communicating artery aneurysm

Olfactory Nerve (CN I)

Function	Special sensory smell
Lesion effect	Anosmia
Vulnerable anatomy	Olfactory filaments at the cribriform plate
Key causes	Head injury, tumours, viral infections

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Ammonia or other irritants are suitable for testing olfaction
- ✓ Irritants stimulate trigeminal endings, giving a false impression of smell detection
- ✗ CN I lesions localise to a brainstem nucleus
- ✓ Relevant anatomy is olfactory mucosa, cribriform plate, bulb and tract
- ✗ Post-traumatic anosmia is unrelated to skull fracture
- ✓ Suggests cribriform plate involvement, especially with CSF rhinorrhoea

Optic Nerve (CN II)

Scotoma in one eye	Retina
Complete monocular blindness	Optic nerve
Bitemporal hemianopia	Optic chiasma
Contralateral homonymous hemianopia	Optic tract, lateral geniculate body, optic radiation or visual cortex
Contralateral homonymous hemianopia with macular sparing	Visual cortex, classically posterior cerebral artery infarction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ A monocular scotoma localises to the optic nerve
- ✓ Scotoma in one eye localises to the retina; complete monocular blindness to the optic nerve
- ✗ Optic tract lesions cause monocular visual loss
- ✓ Post-chiasmal lesions cause contralateral homonymous hemianopia
- ✗ Bitemporal hemianopia localises to the optic nerve
- ✓ Optic chiasma

Trigeminal Nerve (CN V)

Main sensory role	Principal sensory nerve of the face
Divisions	V1 ophthalmic, V2 maxillary, V3 mandibular
Motor component	Travels with V3 to muscles of mastication
Trigeminal neuralgia	Brief, severe, triggerable unilateral facial pain in CN V territory
Corneal reflex	Afferent V1; efferent CN VII
Jaw jerk	Lost if motor root is affected
Common causes	Tumours, multiple sclerosis, trauma

EXAM TRAPS × tempting option ✓ correct answer

- × Trigeminal lesions cause weakness of facial expression
- ✓ Facial expression is CN VII; CN V gives facial sensory loss and mastication weakness
- × A lost corneal reflex always indicates a V1 lesion
- ✓ Afferent V1 or efferent CN VII failure; accompanying signs distinguish them
- × V2 carries motor fibres to the muscles of mastication
- ✓ Only V3 has a motor component; lost jaw jerk or mastication weakness implies motor root involvement

Vagus Nerve (CN X)

Main unilateral effects	Hoarseness, dysphagia, uvular deviation away from lesion
Voice change mechanism	Recurrent laryngeal nerve involvement
Palatal sign	Weak side droops; intact side pulls uvula away from lesion
Bilateral lesion risk	Potentially life-threatening airway compromise
Left recurrent laryngeal vulnerability	Long thoracic course around the aortic arch
Common causes	Tumours, jugular foramen pathology, neck surgery, aortic aneurysm

EXAM TRAPS × tempting option ✓ correct answer

- × In unilateral vagal palsy the uvula deviates towards the lesion
- ✓ Uvula deviates away from the lesion; intact side pulls it over
- × Hoarseness in a vagal lesion is non-localising
- ✓ Points to recurrent laryngeal nerve involvement
- × Aortic aneurysm mainly threatens the right recurrent laryngeal nerve
- ✓ Left recurrent laryngeal nerve, which loops around the aortic arch
- × Bilateral vocal cord palsy is mainly a voice problem
- ✓ Potentially life-threatening airway compromise

Vestibulocochlear Nerve (CN VIII)

Nerve type	Special sensory
Cochlear division	Sensorineural hearing loss
Vestibular division	Vertigo, nystagmus, imbalance
Classic tumour association	Acoustic neuroma / vestibular schwannoma
Other common causes	Meniere's disease, ototoxic drugs, trauma, infection
Exam distinction	CN VIII lesions affect hearing and balance, not motor power

EXAM TRAPS × tempting option ✓ correct answer

- × CN VIII lesions cause conductive hearing loss
- ✓ Sensorineural hearing loss
- × Vertigo in CN VIII lesions is a motor deficit
- ✓ Vertigo reflects abnormal vestibular sensory input
- × An isolated CN VIII lesion causes facial weakness
- ✓ Facial weakness implies CN VII or adjacent-structure involvement; CN VIII affects hearing and balance only

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CHAPTER 2

Physiology

6 curriculum topics · 123 subtopics · 365 exam traps

Basic Cellular Physiology · Respiratory Physiology · Cardiovascular Physiology · Gastrointestinal Physiology · Renal Physiology · Endocrine Physiology

PHYSIOLOGY · TOPIC 1 OF 6

Basic Cellular Physiology

Cell Structure and Function

Key Organelles and Their Roles

Mitochondria	Aerobic respiration; oxidative phosphorylation; ATP production
Nucleus	DNA storage; gene expression; cell function and reproduction
Rough ER	Protein synthesis and processing
Smooth ER	Lipid synthesis and drug metabolism
Golgi apparatus	Packaging and secretion of proteins
Lysosomes	Intracellular digestion of waste and pathogens

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Rough ER synthesises lipids and metabolises drugs
- ✓ Smooth ER: lipid synthesis and drug metabolism; rough ER: protein synthesis
- ✗ Rough ER packages and directs proteins for secretion
- ✓ Golgi apparatus packages and directs proteins after ER processing
- ✗ Aerobic ATP is produced mainly by the nucleus or ER
- ✓ Mitochondria, via oxidative phosphorylation
- ✗ Lysosomes digest only pathogens
- ✓ They also digest intracellular waste and damaged material

Membrane Structure

Basic membrane structure	Phospholipid bilayer
Bilayer function	Selective barrier between ICF and ECF
Embedded proteins	Include transport proteins and receptors
Transport proteins	Permit regulated movement of selected substances
GPCRs	Activate intracellular signalling after extracellular ligand binding

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cell membrane is a simple non-selective wall
- ✓ Selective phospholipid bilayer containing transport proteins and receptors
- ✗ Ions and polar molecules diffuse freely through the lipid bilayer
- ✓ They generally need transport proteins to cross

Membrane Transport

The core distinction is between pumps and channels. The sodium-potassium ATPase uses ATP to maintain gradients by moving ions against their gradients. Ion channels allow ions to move down gradients, but only when the relevant gate is open. Together, these mechanisms allow cells to establish gradients and then use them for rapid physiological responses.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Na-K ATPase works by passive diffusion
- ✓ Active, ATP-dependent transport against gradients
- × Na-K ATPase moves 3 K⁺ in and 2 Na⁺ out per cycle
- ✓ 3 Na⁺ out and 2 K⁺ in per cycle
- × Ion channels create and maintain ion gradients
- ✓ Pumps create gradients; channels allow rapid gated movement down gradients

Homeostasis

Compartments and Fluid Spaces in Health

Main fluid compartments	Intracellular fluid and extracellular fluid
Relative distribution	ICF about two-thirds of total body water; ECF about one-third
ECF cations	High Na ⁺ , low K ⁺
ICF cations	Low Na ⁺ , high K ⁺
Na-K ATPase	Maintains Na ⁺ and K ⁺ gradients using ATP
Donnan effect	Impermeant intracellular anions influence chloride distribution

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Potassium is mainly extracellular and sodium mainly intracellular
- ✓ Sodium mainly extracellular; potassium mainly intracellular
- × Na⁺ and K⁺ gradients are maintained passively
- ✓ Maintained by the active, ATP-dependent Na-K ATPase

Principles of Homeostasis

Homeostasis	Dynamic maintenance of a stable internal environment.
Set point	A narrow range of values within which normal function occurs.
Negative feedback	Corrective response opposes the original disturbance.
Core components	Receptor, comparator and effector.
Oscillation	Small variation around the set point caused by feedback lag time.
Positive feedback	Amplifies change; useful only when time-limited or endpoint-controlled.
Protein protection	Stable pH, temperature and ionic environment preserve protein shape and function.

EXAM TRAPS × tempting option ✓ correct answer

- × Homeostasis keeps variables absolutely constant
- ✓ Variables oscillate within a narrow range around the set point, due to feedback lag
- × Receptors compare the measured value against the set point
- ✓ The comparator does; receptors detect change, effectors respond
- × All physiological feedback is negative
- ✓ Positive feedback exists but is unstable and needs a limiting endpoint
- × Homeostasis matters mainly for cell volume, not protein function
- ✓ Abnormal pH, temperature or ionic composition alters protein structure and function

Osmosis and Fluid Dynamics

Osmolarity and Osmolality

Osmole	A particle contributing to osmotic force
Osmolarity	Osmoles per litre of solution (mOsm/L)
Osmolality	Osmoles per kilogram of solvent (mOsm/kg)
Clinical preference	Osmolality is the usual clinical measurement for plasma and urine
Main determinant of plasma osmolality	Sodium and accompanying anions, with glucose and urea contributing

EXAM TRAPS × tempting option ✓ correct answer

- × Osmolality is measured in osmoles per litre of solution
- ✓ Per kilogram of solvent (mOsm/kg); osmolarity is per litre
- × Molarity and osmotic concentration are always identical
- ✓ Dissociation into ions increases the number of osmotically active particles

Osmosis

Osmosis	Water moves across a semi-permeable membrane from low to high solute concentration
Driving force	Solute concentration gradient across the membrane
Isotonic fluid	Same tonicity as plasma; no net cell water movement
Hypotonic fluid	Lower tonicity than plasma; water moves into cells
Hypertonic fluid	Higher tonicity than plasma; water moves out of cells
Clinical physiological principle	Cell volume changes follow extracellular tonicity

EXAM TRAPS × tempting option ✓ correct answer

- × In osmosis water moves towards the lower solute concentration
- ✓ Water moves towards the higher solute concentration
- × Fluid volume taken in predicts the direction of cell water movement
- ✓ Tonicity predicts direction of cell water movement, not volume
- × Hypotonic fluid makes cells shrink
- ✓ Hypotonic makes cells swell; hypertonic makes cells shrink

Plasma Contents

Feature	Essential detail	Physiological importance
Main source of oncotic pressure	Large plasma proteins, primarily albumin	Draws water towards the intravascular compartment
Albumin	Most important contributor to plasma oncotic pressure	Helps maintain circulating plasma volume
Binding function	Reversibly binds substances such as fatty acids, bilirubin, calcium, hormones and many drugs	Provides a circulating reservoir and influences free active fraction
Low albumin	Reduced plasma oncotic pressure	Favours movement of water into interstitial tissue and oedema

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Oncotic pressure is generated by small plasma solutes
- ✓ Large plasma proteins, primarily albumin; small solutes generate osmotic pressure
- × Albumin's only important role is oncotic pressure
- ✓ It also binds fatty acids, bilirubin, calcium, hormones and drugs
- × Albumin's oncotic effect pushes fluid out of vessels
- ✓ It draws water into, or retains water within, the plasma

Vessel Fluid Dynamics

Permeability

Permeability	Ease of movement across a vessel wall or membrane.
Membrane thickness	Thicker barrier reduces exchange.
Surface area	Larger surface area increases possible exchange.
Pores/junctions	Determine movement of water-soluble substances.
Lipid solubility	Increases passage through lipid membranes.
Diffusion coefficient	Higher coefficient means faster diffusion under equivalent conditions.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Permeability is the pressure gradient driving flow across a barrier
- ✓ Permeability is ease of crossing the barrier, not the pressure gradient
- × All substances cross a membrane equally easily
- ✓ Permeability is selective, depending on barrier and substance

Tube Flow

- Flow requires a pressure difference; movement is from higher to lower pressure.
- Flow is reduced by longer tube length, smaller radius and higher viscosity.
- Radius is the dominant variable because flow is proportional to radius to the fourth power.
- Laminar flow is smooth, layered and efficient; turbulent flow is chaotic, less efficient and may generate bruits or murmurs.

EXAM TRAPS × tempting option ✓ correct answer

- × Halving vessel radius halves flow
- ✓ Flow is proportional to r^4 , so halving radius reduces flow sixteen-fold
- × Pressure alone determines the amount of flow
- ✓ Pressure difference drives flow; resistance determines how much occurs

Wall Tension

Wall tension	Force borne by the wall of a pressurised tube or chamber.
Core relationship	Wall tension increases with pressure and radius, and decreases with wall thickness.
Wall thickness	Increased wall thickness reduces tension per unit thickness; thinning increases vulnerability.
Dilated cardiomyopathy	Increased ventricular radius increases wall tension, myocardial oxygen demand and mechanical inefficiency.
Aortic aneurysm	Increased vessel radius and often reduced wall integrity increase wall tension and risk of expansion or rupture.

EXAM TRAPS × tempting option ✓ correct answer

- × Wall tension and tube flow are the same concept
- ✓ Radius affects both, but flow and wall stress are different concepts
- × Wall thickness does not affect wall tension
- ✓ Thin walls increase tension per unit thickness; thin-walled aneurysms are more vulnerable
- × Wall tension rises only if pressure rises
- ✓ Dilatation (increased radius) raises wall tension even without raised pressure

Blood and Blood Flow

Normal Blood Values

Hb	Male 13.5-17.5 g/dL; female 11.5-15.5 g/dL
Haematocrit	Male 40-52%; female 36-48%
Platelets	$150-400 \times 10^9/L$
White cells	$4-11 \times 10^9/L$

EXAM TRAPS × tempting option ✓ correct answer

- × Haematocrit is measured in g/dL
- ✓ Haematocrit is a percentage; Hb is in g/dL
- × Normal Hb and haematocrit ranges are the same in both sexes
- ✓ Higher in males: Hb 13.5-17.5 vs 11.5-15.5 g/dL
- × Normal white cell count is $150-400 \times 10^9/L$
- ✓ That is platelets; white cells are $4-11 \times 10^9/L$

Plasma

Main plasma protein	Albumin
Key transport role	Binding protein for many substances in plasma

Key fluid role	Major contributor to plasma oncotic pressure
Direction of oncotic effect	Draws water towards the intravascular space
Low albumin effect	Reduced oncotic pressure, promoting oedema formation

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oncotic pressure pushes fluid out of capillaries
- ✓ That is hydrostatic pressure; oncotic pressure draws water towards plasma proteins
- ✗ Protein-bound drug is the immediately active fraction
- ✓ The unbound (free) fraction is the immediately active component

Platelets and Coagulation

Initial platelet response	Adhesion, activation and aggregation
5-HT	Vasoconstriction
Thromboxane A2	Platelet aggregation and vasoconstriction
Thrombin	Promotes clot formation, especially fibrin generation
Fibrin	Stabilises the platelet plug

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Fibrin forms the initial plug in primary haemostasis
- ✓ Platelets form the initial plug; fibrin stabilises it
- ✗ Thromboxane A2 causes platelet aggregation only
- ✓ Both platelet aggregation and vasoconstriction

Red Blood Cells

Step	Physiological event	Result
1	Reduced renal oxygen delivery or tissue hypoxia	Peritubular renal cells increase EPO production
2	EPO reaches red bone marrow via the blood	Erythroid precursor survival and maturation increase
3	More reticulocytes and red cells enter circulation	Haemoglobin mass and oxygen-carrying capacity rise
4	Oxygen delivery improves	EPO stimulus decreases through negative feedback

Main red cell function	Oxygen transport
Key red cell component	Haemoglobin
Main red cell production site	Red bone marrow
Main hormonal stimulant	Erythropoietin (EPO)
Main EPO source	Renal peritubular interstitial cells
Main EPO stimulus	Hypoxia
Major site of aged RBC removal	Spleen

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oxygen tension alone determines blood oxygen content
- ✓ Haemoglobin concentration strongly determines total oxygen content
- ✗ Erythropoietin is produced mainly by the bone marrow
- ✓ Kidney (peritubular interstitial cells); marrow is the target organ
- ✗ The spleen produces normal adult red cells
- ✓ Red bone marrow produces them; spleen sequesters and destroys aged cells

White Blood Cells

Main function	Immunity and defence against infection
Generic name	Leucocytes
Innate defence	Rapid, non-specific defence; neutrophils and macrophages are key examples
Adaptive defence	Specific immune responses; lymphocytes are key cells
Infection response	Recruitment from blood into tissues, followed by pathogen killing and immune coordination

EXAM TRAPS × tempting option ✓ correct answer

- ✗ White blood cells primarily transport substances in blood
- ✓ Their core function is immunity and infection defence
- ✗ White cells act only within the bloodstream
- ✓ They are recruited into tissues; circulating count is only part of their physiology

Neurological Action Potential

Membrane Potentials

Membrane potential	Electrical difference across a cell membrane.
General principle	Present as a property of all cell membranes.
Resting membrane potential	Baseline electrical state caused by asymmetric ion distribution.
Main ions	Na ⁺ mainly extracellular; K ⁺ mainly intracellular.
Maintaining mechanism	Na-K ATPase preserves Na ⁺ and K ⁺ gradients using ATP.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Membrane potentials occur only in neurones
- ✓ They are a property of all cell membranes
- ✗ Sodium is mainly intracellular and potassium mainly extracellular
- ✓ Sodium mainly extracellular; potassium mainly intracellular
- ✗ Na-K ATPase is a passive process
- ✓ Active and ATP-dependent

Conduction of the Action Potential

Saltatory conduction	Action potential propagation in myelinated fibres, with regeneration at nodes of Ranvier.
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Nodes of Ranvier	Gaps in myelin where voltage-gated channels allow the action potential to be regenerated.
Myelination	Increases conduction speed and improves energy efficiency.
Unmyelinated fibres	Conduct more slowly because the action potential is regenerated continuously along the membrane.
Fibre diameter	Larger diameter gives faster conduction due to lower internal resistance.
Same diameter comparison	Myelinated fibres conduct faster than unmyelinated fibres.

EXAM TRAPS × tempting option ✓ correct answer

- × Ions physically travel the whole length of the nerve
- ✓ The action potential is regenerated along the membrane
- × Saltatory conduction depends on myelin alone
- ✓ Requires both myelin and nodes of Ranvier with voltage-gated channels
- × Myelination only increases conduction speed
- ✓ It also improves energy efficiency
- × Larger diameter fibres conduct more slowly
- ✓ Larger fibres conduct faster due to lower internal resistance

The Action Potential

Excitable tissues	Nerve and muscle generate action potentials.
Threshold	The membrane voltage at which a full action potential is triggered.
Depolarisation	Rapid Na ⁺ influx through voltage-gated Na ⁺ channels.
All-or-nothing	A full action potential occurs once threshold is reached; subthreshold stimuli do not generate one.
Repolarisation	K ⁺ efflux restores the membrane towards resting potential.
Hyperpolarisation	Temporary undershoot after repolarisation.
Absolute refractory period	No action potential possible because Na ⁺ channels are inactivated.
Relative refractory period	A stronger stimulus is required to generate another action potential.

EXAM TRAPS × tempting option ✓ correct answer

- × Action potentials are generated by all cells
- ✓ Only excitable tissues (nerve, muscle); membrane potentials exist in all cells
- × A bigger suprathreshold stimulus produces a bigger action potential
- ✓ All-or-nothing: same size once threshold is reached
- × A strong enough stimulus can trigger an action potential in the absolute refractory period
- ✓ Impossible; Na⁺ channels are inactivated. Only the relative refractory period can be overcome
- × Repolarisation is caused by Na⁺ influx
- ✓ Na⁺ influx depolarises; K⁺ efflux repolarises

Muscle Physiology

Cardiac Muscle

Involuntary muscle	Cardiac contraction is not under conscious somatic motor control.
Intercalated discs	Contain gap junctions and desmosomes.

Electrical syncytium	Depolarisation spreads between cells to coordinate contraction.
No tetany	Long absolute refractory period protects relaxation and filling.
Calcium handling	L-type Ca^{2+} entry triggers calcium-induced calcium release from the SR.
Starling relationship	Higher EDV increases stretch and therefore force of contraction, within limits.

EXAM TRAPS × tempting option ✓ correct answer

- × Cardiac muscle can summate and tetanise like skeletal muscle
- ✓ It cannot, because of its long absolute refractory period
- × Cardiac contraction relies solely on SR calcium, not extracellular Ca^{2+}
- ✓ L-type Ca^{2+} entry triggers calcium-induced calcium release; it is essential
- × The myocardium is a true anatomical syncytium
- ✓ A functional electrical syncytium produced by gap junctions in intercalated discs

Muscle Morphologies Overview

Skeletal	Voluntary movement; fast contraction; relatively fatigable.
Smooth	Involuntary visceral and vascular control; slow, sustained contraction.
Cardiac	Involuntary rhythmic contraction; highly fatigue-resistant pump muscle.

EXAM TRAPS × tempting option ✓ correct answer

- × Smooth muscle is fatigable like skeletal muscle
- ✓ Smooth muscle produces slow, sustained involuntary contraction
- × Cardiac muscle is a form of smooth muscle
- ✓ Distinct type: involuntary, rhythmic and highly fatigue-resistant

Skeletal Muscle

Functional unit	Sarcomere
Cell membrane	Sarcolemma
Calcium store	Sarcoplasmic reticulum
Main filaments	Thick myosin and thin actin filaments
Trigger for contraction	Calcium binding to troponin C
Energy source	ATP for cross-bridge cycling and calcium re-uptake
Temporal summation	Successive stimuli increase force
Spatial summation	More motor units recruited to increase force
Motor unit	One motor neurone plus all fibres it supplies

EXAM TRAPS × tempting option ✓ correct answer

- × Spatial summation means increasing stimulus frequency
- ✓ Spatial is motor unit recruitment; temporal relates to stimulus frequency
- × ATP is needed only for contraction, not relaxation
- ✓ ATP also powers calcium re-uptake into the sarcoplasmic reticulum for relaxation
- × The myofibril is the functional contractile unit of skeletal muscle
- ✓ The sarcomere

Autonomic Nervous System

Neurochemical Synaptic Transmission

Presynaptic bouton	Terminal region where vesicles release neurotransmitter.
Calcium	Triggers vesicle fusion and neurotransmitter exocytosis.
Post-synaptic excitation	Receptor activation increases activity of the target cell.
Presynaptic inhibition	Reduces transmitter release from the nerve terminal.
Acetylcholine removal	Cholinesterase degradation.
Catecholamine removal	MAO and COMT degradation.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Sodium entry directly triggers vesicle fusion at the presynaptic bouton
- ✓ Calcium entry triggers vesicle fusion and exocytosis
- × All synaptic inhibition is post-synaptic
- ✓ Presynaptic inhibition reduces transmitter release from the terminal
- × MAO degrades acetylcholine
- ✓ Cholinesterase degrades acetylcholine; MAO and COMT degrade catecholamines

Overview

Core function	Effector arm of homeostasis
Control type	Involuntary, rapid neural regulation
Main divisions	Sympathetic and parasympathetic
Pathway structure	Preganglionic neurone, autonomic ganglion, postganglionic neurone
Effector tissues	Cardiac muscle, smooth muscle and glands

Principal Effects of Autonomic Stimulation

Heart	Sympathetic increases rate and force; parasympathetic decreases rate.
Blood vessels	Sympathetic vasoconstriction is mainly alpha-1 mediated; skeletal muscle vasodilatation also occurs.
Lungs	Sympathetic beta-2 activity bronchodilates; parasympathetic activity bronchoconstricts and increases secretions.
Gut	Sympathetic activity slows motility and tightens sphincters; parasympathetic activity increases motility and relaxes sphincters.
Eyes	Sympathetic mydriasis; parasympathetic miosis and accommodation.
Adrenals	Sympathetic stimulation releases catecholamines.

EXAM TRAPS × tempting option ✓ correct answer

- × All sympathetic vascular effects are vasoconstrictive
- ✓ Skeletal muscle vascular beds can vasodilate; vasoconstriction is mainly α -1
- × Sympathetic stimulation constricts the pupil
- ✓ Sympathetic causes mydriasis; parasympathetic causes miosis and accommodation
- × Parasympathetic lung effect is bronchoconstriction only
- ✓ Bronchoconstriction and increased secretions
- × Adrenal catecholamine release is a parasympathetic effect
- ✓ Sympathetic stimulation releases adrenal catecholamines

PHYSIOLOGY · TOPIC 2 OF 6

Respiratory Physiology

Lung Volumes and Pressures

Definitions and Typical Adult Values

TV	One normal breath: about 500 mL
VC	Maximum expired after maximum inspiration: about 4.8 L
RV	Remaining after maximum expiration: about 1.2 L; not measured by simple spirometry
FRC	End-normal-expiration volume; RV + expiratory reserve volume; balance of lung and chest wall recoil
Anatomical dead space	Conducting airways; about 150 mL
Alveolar dead space	Ventilated but not perfused alveoli; minimal in health, increased in pulmonary embolism

EXAM TRAPS × tempting option ✓ correct answer

- × Functional residual capacity is the volume after maximal expiration
- ✓ That is RV; FRC is volume after normal quiet expiration (RV + ERV)
- × A 500 mL tidal breath gives 500 mL alveolar ventilation
- ✓ About 150 mL fills anatomical dead space
- × Alveolar dead space is a ventilation problem
- ✓ Perfusion problem: alveolus ventilated but blood flow absent or reduced, e.g. pulmonary embolism
- × Residual volume can be measured by simple spirometry
- ✓ Cannot: RV is never exhaled

Epithelial Function in Health

Feature	Main physiological role	Exam relevance
Ciliated columnar epithelium	Coordinated ciliary beating moves mucus upwards towards the pharynx.	Basis of the mucociliary escalator.
Mucus	Traps particles and pathogens; contains protective proteins including antitrypsins and antimicrobial proteins.	Both excess thickness and inadequate trapping impair defence.
Type I pneumocytes	Thin cells forming most of the alveolar surface.	Primary alveolar cell for efficient gas exchange.

Feature	Main physiological role	Exam relevance
Type II pneumocytes	Cuboidal cells that produce surfactant and regenerate Type I cells.	Links epithelial function to alveolar stability and repair.

Healthy respiratory epithelium protects the lung by combining mechanical clearance with specialised alveolar cell function. Cilia move mucus proximally, mucus traps and neutralises inhaled material, and pneumocytes maintain the alveolar surface for gas exchange. The most important clinical principle is that mucus viscosity must be balanced: if mucus becomes too thick, clearance fails; if it is too thin, pathogen trapping is reduced.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Pneumocytes clear mucus in the conducting airways
- ✓ Ciliated columnar cells clear mucus; pneumocytes line alveoli
- ✗ Type II pneumocytes form most of the alveolar surface
- ✓ Type I pneumocytes; Type II produce surfactant
- ✗ Lower mucus viscosity is always beneficial
- ✓ Too-thin mucus traps pathogens less well

Lung Compliance

Alveolar Surface Tension and Surfactant

Laplace law	Pressure = $2T/r$.
Small alveoli without surfactant	Higher collapsing pressure; tendency to empty into larger alveoli.
Surfactant source	Type II pneumocytes.
Surfactant composition	Tension-reducing phospholipid mixture, primarily DPPC.
Main physiological effect	Reduces surface tension, increases compliance and prevents atelectasis.
Reduced surfactant	Neonatal RDS and ARDS: stiff lungs with increased work of breathing.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Smaller alveoli have lower collapsing pressure
- ✓ $P = 2T/r$: smaller radius raises collapsing pressure at constant tension
- ✗ Surfactant matters most at high lung volumes
- ✓ Most important at low volumes, stabilising small alveoli
- ✗ Type I pneumocytes produce surfactant
- ✓ Type II produce surfactant; Type I are for gas exchange
- ✗ Reduced surfactant is relevant only in neonates
- ✓ Also in ARDS

Compliance Overview

Definition	Change in volume per change in pressure.
High compliance	Easy expansion; large volume change for small pressure change.
Low compliance	Stiff system; greater pressure required for the same volume.
Static compliance	Measured without airflow; mainly elastic behaviour.
Dynamic compliance	Measured during breathing; includes airway resistance.

Fibrosis	Reduces static compliance.
Obstructive disease	Reduces dynamic compliance because resistance is increased.

EXAM TRAPS × tempting option ✓ correct answer

- × Compliance and elastic recoil are the same concept
- ✓ They are opposing concepts
- × Compliance is highest at total lung capacity
- ✓ Pressure-volume curve flattens at very high volumes, so compliance falls
- × Static compliance includes the effect of airway resistance
- ✓ Dynamic compliance includes airway resistance; static is measured without airflow
- × Obstructive disease mainly reduces static compliance
- ✓ Fibrosis reduces static compliance; obstruction reduces dynamic compliance via resistance

Airway Resistance

Determinants of Airway Resistance

Main determinant	Airway radius/calibre
Sympathetic effect	Beta-2 bronchodilation: resistance decreases
Parasympathetic effect	Bronchoconstriction: resistance increases
Asthma mechanisms	Bronchospasm, mucosal oedema, excess mucus secretion
Clinical result	Reduced airflow and increased work of breathing

EXAM TRAPS × tempting option ✓ correct answer

- × Parasympathetic activity dilates the airways
- ✓ Beta-2 sympathetic activity dilates; parasympathetic constricts
- × Asthma obstruction is caused by bronchospasm alone
- ✓ Also mucosal oedema and excess mucus secretion
- × Loud wheeze always indicates the most severe obstruction
- ✓ In life-threatening obstruction airflow may be too low to generate wheeze

Lung Function Tests

PEFR	Effort-dependent measure of maximum expiratory flow; depends on starting lung volume.
Normal PEFR	Male ~550-650 L/min; female ~400-500 L/min.
FEV1/FVC	Composite spirometric ratio; normal adult value >0.7 (>70%).
Obstructive pattern	FEV1/FVC <0.7, e.g. asthma or COPD.
Restrictive pattern	FEV1/FVC normal or increased, but FVC reduced.

EXAM TRAPS × tempting option ✓ correct answer

- × PEFR depends only on disease severity
- ✓ Highly effort- and technique-dependent
- × PEFR is independent of starting lung volume
- ✓ Depends on initial volume; poor inspiration lowers the result
- × Any low spirometric value indicates obstruction
- ✓ Obstruction: FEV1/FVC <0.7; restriction: reduced FVC with normal or raised ratio

Gas Transport

Alveolar Diffusion

Core mechanism	Passive diffusion across the alveolar-capillary membrane
Driving force	Partial pressure difference
Area effect	Reduced area reduces gas transfer and TLCO/DLCO
Thickness effect	Increased thickness reduces gas transfer and TLCO/DLCO
Diffusion-limited example	Carbon monoxide
Perfusion-limited example	Oxygen in health

EXAM TRAPS × tempting option ✓ correct answer

- × Reduced membrane area and increased thickness are the same mechanism
- ✓ Both reduce TLCO/DLCO, but by different mechanisms
- × Oxygen transfer is diffusion-limited in health
- ✓ Perfusion-limited in health; carbon monoxide is diffusion-limited

Gas Pressures

Partial pressure	Contribution of an individual gas to total barometric pressure
Dalton's law	Total pressure equals the sum of component gas partial pressures
Room air PO₂	~21 kPa (~160 mmHg)
Room air PN₂	~79 kPa (~600 mmHg)
Inspired air	PO ₂ ~21 kPa; PCO ₂ ~0.04 kPa
Alveolar air	PO ₂ ~13.5 kPa; PCO ₂ ~5.3 kPa
Expired air	PO ₂ ~16 kPa; PCO ₂ ~4 kPa
Henry's law	Dissolved gas quantity is proportional to partial pressure above the fluid

EXAM TRAPS × tempting option ✓ correct answer

- × Oxygen's physiological effect is described by its 21% concentration
- ✓ Described by partial pressure (PO₂ ~21 kPa in room air)
- × Alveolar gas composition equals inspired air
- ✓ Alveolar PO₂ lower (~13.5 kPa), PCO₂ much higher (~5.3 kPa)
- × Expired air is identical to alveolar air
- ✓ Expired air includes anatomical dead-space gas (PO₂ ~16, PCO₂ ~4 kPa)
- × Dalton's law describes gas dissolved in a fluid
- ✓ Henry's law; Dalton's describes partial pressures in a gas mixture

Gas Transport Within the Circulation

Anaemia and the Dissociation Curve

Low Hb and PO₂	PO ₂ unchanged if lung gas exchange is normal.
Low Hb and saturation	Saturation unchanged because it is a percentage of available Hb binding sites occupied.
Low Hb and oxygen content	Oxygen content reduced because there is less Hb to carry oxygen.
Anaemia curve shape	Normal sigmoid shape, with right shift in chronic anaemia.
Cause of right shift	Increased 2,3-DPG in chronic anaemia.
HbF	Left shift; higher oxygen affinity supports maternal-to-foetal oxygen transfer.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Normal SpO₂ in anaemia means normal arterial oxygen content
- ✓ Oxygen content is reduced; saturation stays normal because it is a percentage of available Hb sites
- × Anaemia lowers arterial PO₂
- ✓ PO₂ is unchanged in anaemia unless there is an additional gas-exchange problem
- × Chronic anaemia shifts the dissociation curve to the left
- ✓ Right shift: increased 2,3-DPG aids oxygen release to tissues
- × HbF shifts the oxygen dissociation curve to the right
- ✓ Left shift; HbF has higher oxygen affinity than adult haemoglobin

Carbon Dioxide Transport

Dissolved CO₂	~7%; determines PCO ₂
Bicarbonate	~70%; major carriage form
Carbaminohaemoglobin	~23%; CO ₂ bound to amino groups of haemoglobin
Carbonic anhydrase	Catalyses CO ₂ hydration in red blood cells
Chloride shift	HCO ₃ ⁻ exits RBC in exchange for Cl ⁻ entry
Haldane effect	Deoxygenated Hb carries CO ₂ and buffers H ⁺ more effectively

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Most CO₂ is carried dissolved in plasma
- ✓ Bicarbonate (~70%); dissolved CO₂ is only ~7%
- × Carbaminohaemoglobin is carbon monoxide bound to haemoglobin
- ✓ Carbaminohaemoglobin is CO₂ bound to haemoglobin; carboxyhaemoglobin is carbon monoxide bound
- × Bicarbonate leaves the red cell in exchange for sodium entry
- ✓ Chloride shift: HCO₃⁻ exits in exchange for Cl⁻ entry, maintaining electrochemical neutrality
- × Oxygenated haemoglobin carries CO₂ more effectively
- ✓ Deoxygenated Hb carries CO₂ better (Haldane effect); oxygenation in the lungs promotes CO₂ unloading

Oxygen Transport

Main carrier of oxygen	Haemoglobin within red blood cells.
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Capacity per haemoglobin molecule	Four oxygen molecules, one per haem group.
Curve shape	Sigmoid due to co-operative binding.
Right shift	Reduced affinity; more oxygen released to tissues.
Left shift	Increased affinity; less oxygen released to tissues.
Bohr effect	Increased PCO ₂ and decreased pH shift the curve to the right.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oxygen saturation and PO₂ measure the same thing
- ✓ Saturation describes haemoglobin binding; PO₂ reflects dissolved oxygen tension
- ✗ A right shift makes haemoglobin hold oxygen more tightly
- ✓ Right shift releases oxygen to tissues; left shift holds oxygen more tightly
- ✗ Carbon monoxide only reduces available binding sites, without shifting the curve
- ✓ CO also shifts the remaining oxygen dissociation curve to the left

Ventilation-Perfusion Relationship

Anatomical Right-to-Left Shunts

Definition	Venous blood entering systemic arterial blood without complete exposure to ventilated alveoli.
Normal anatomical shunts	Bronchial venous drainage into pulmonary veins; Thebesian venous drainage into left heart chambers.
Lung disease mechanism	Perfusion of non-ventilated or poorly ventilated lung regions, such as pneumonia or ARDS.
Heart disease mechanism	Right-to-left passage of deoxygenated blood through abnormal communications such as VSD, ASD or PDA.
Oxygen response	True shunt has limited response to supplemental oxygen compared with V/Q mismatch.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ All hypoxaemia corrects fully with supplemental oxygen
- ✓ True shunt responds poorly to supplemental oxygen, unlike V/Q mismatch
- ✗ Dead space is perfusion without ventilation
- ✓ Dead space is ventilation without perfusion; shunt is perfusion without effective ventilation
- ✗ Right-to-left anatomical shunts occur only in disease
- ✓ Small normal shunts exist: bronchial venous and Thebesian venous drainage

V/Q Mismatch

High V/Q	Ventilation exceeds perfusion; dead-space pattern.
Low V/Q	Perfusion exceeds ventilation; shunt-like pattern.
Dead space	Ventilated but unperfused alveoli; wasted ventilation; may raise PaCO ₂ .
Shunt	Perfused but unventilated alveoli; venous admixture; lowers PaO ₂ .
Oxygen response	V/Q mismatch improves with FiO ₂ ; true shunt responds poorly.
Elderly lungs	Dependent airway closure can increase low V/Q mismatch with age.

EXAM TRAPS × tempting option ✓ correct answer

- × Shunt wastes ventilation
- ✓ Shunt wastes perfusion; dead space wastes ventilation
- × Hypoxaemia from true shunt corrects with increased FiO_2
- ✓ True shunt responds poorly to increased FiO_2 ; V/Q mismatch improves
- × Dead space always raises PaCO_2
- ✓ Only when compensatory ventilation is inadequate

Control of Respiration

Stretch and Irritant Receptors

Stretch receptors	Located in the bronchial wall and activated by lung inflation.
Afferent pathway	Primarily vagal afferents to brainstem respiratory centres.
Hering-Breuer reflex	Lung inflation inhibits inspiration.
Irritant receptors	Activated by airway irritants and retained secretions.
Cough	Protective reflex helping clear irritants and mucus from the airway.
Bronchoconstriction	Reflex response to airway irritation; increases airway resistance.

EXAM TRAPS × tempting option ✓ correct answer

- × Stretch receptors produce cough and bronchoconstriction
- ✓ Stretch receptors inhibit inspiration; irritant receptors produce cough and bronchoconstriction
- × The Hering-Breuer reflex is a chemoreceptor reflex
- ✓ It is a lung inflation stretch reflex, not a CO_2 or O_2 response
- × Bronchoconstriction is only a direct smooth muscle response
- ✓ Airway irritation can also trigger reflex bronchoconstriction via irritant receptors

Central Control Centres

Primary automatic control	Brainstem respiratory centres, especially the medulla.
DRG	Main inspiratory drive, particularly in quiet breathing.
VRG	Active in forced breathing and increased ventilatory demand.
Pneumotaxic centre	Limits inspiration; contributes to respiratory rate control.
Apneustic centre	Prolongs inspiration; normally restrained by pneumotaxic activity.
Hering-Breuer reflex	Lung inflation activates stretch receptors, inhibiting further inspiration.
Voluntary pathway	Cortical motor neurones via pyramidal/corticospinal tracts.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The apneustic centre limits inspiration
- ✓ Pneumotaxic centre limits inspiration; apneustic centre prolongs it
- × The VRG is the main driver of quiet breathing
- ✓ DRG drives quiet inspiration; VRG is most important in forced breathing
- × Quiet expiration requires active respiratory muscle contraction
- ✓ Quiet expiration is usually passive; forced expiration recruits active muscles
- × Voluntary breath control originates in the brainstem respiratory centres
- ✓ Cortical motor neurones via corticospinal (pyramidal) pathways

Chemoreceptors

Most powerful ventilatory stimulus	Rising arterial PCO ₂ .
Central chemoreceptor stimulus	Fall in CSF pH caused by CO ₂ crossing the blood-brain barrier.
Central chemoreceptors respond to PO₂?	No direct response to PO ₂ .
Peripheral chemoreceptor sites	Carotid bodies and aortic bodies.
Main peripheral stimulus	Falling arterial PO ₂ , especially below approximately 8 kPa.
Metabolic acidosis response	Increased ventilation to lower PCO ₂ .
Metabolic alkalosis response	Reduced ventilation to retain PCO ₂ , limited by oxygenation.
Combined low PO₂ and high PCO₂	Synergistic increase in ventilation.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Central chemoreceptors directly detect arterial PO₂
- ✓ They do not respond to PO₂; peripheral chemoreceptors detect hypoxaemia
- × Oxygen is the main normal driver of ventilation
- ✓ In health, CO₂ is the dominant ventilatory stimulus
- × Peripheral chemoreceptor response to PO₂ is linear across all values
- ✓ Response becomes much more important below approximately 8 kPa
- × Metabolic alkalosis causes compensatory hyperventilation
- ✓ Metabolic alkalosis tends towards hypoventilation; metabolic acidosis causes hyperventilation

J Receptors (Juxtacapillary Receptors)

Location	Alveolar interstitium close to pulmonary capillaries
Main afferent route	Mainly vagal afferents
Main effect	Tachypnoea, often rapid shallow breathing
Pulmonary oedema	Fluid and interstitial expansion stimulate receptors
Pulmonary emboli	Vascular obstruction and local pulmonary stress can stimulate reflex tachypnoea
Pulmonary inflammation	Inflammatory irritation and oedema stimulate receptors

EXAM TRAPS × tempting option ✓ correct answer

- × J receptors mediate cough and bronchoconstriction
- ✓ That is irritant receptors; J receptors cause tachypnoea from alveolar-capillary disturbance
- × Tachypnoea is always chemoreceptor-mediated
- ✓ Pulmonary oedema, emboli and inflammation can increase rate via J receptor reflexes
- × J receptors lie in the large conducting airways
- ✓ Juxta-capillary: alveolar interstitium close to pulmonary capillaries

PHYSIOLOGY · TOPIC 3 OF 6

Cardiovascular Physiology

Systemic Overview

Cardiovascular Components and Functions

Arteries	Elastic pulsation-dampening distribution vessels
Capillaries	Sites of exchange
Venules	Return pathway from capillary beds
Veins	Thin-walled capacitance and return vessels
Blood volume	~5 L or 70 mL/kg
Cardiac output	~5 L/min at rest
Stroke volume	~70 mL
MAP	Diastolic pressure + one-third pulse pressure
Capillary pressures	~35 mmHg before capillary bed; ~15 mmHg after capillary bed
CVP	Approximately 2-8 mmHg (about 3-10 cmH ₂ O)

EXAM TRAPS × tempting option ✓ correct answer

- × MAP equals the average of systolic and diastolic pressure
- ✓ Diastolic pressure plus one-third of the pulse pressure
- × Arteries are the major resistance vessels
- ✓ Arterioles are; arteries distribute flow and dampen pulsation
- × A CVP of 2-8 mmHg equals 2-8 cmH₂O
- ✓ About 3-10 cmH₂O, since 1 mmHg is about 1.36 cmH₂O
- × A large change in venous volume causes a large venous pressure change
- ✓ Veins are capacitance vessels; large volume changes produce only small pressure changes

Cardiac Cycle I – Electrical Initiation

AV Node

Main function	Relays atrial electrical activity towards the ventricles
Defining property	Relatively slow conduction
Cellular basis	Small AV nodal cell size slows conduction
Duration of delay	Approximately 0.1 seconds
Mechanical purpose	Allows atrial contraction to complete before ventricular contraction

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The AV node normally originates the cardiac cycle
- ✓ The SA node originates it; the AV node delays and relays
- ✗ AV nodal delay is pathological
- ✓ Normal physiological delay (~0.1 s) allowing atrial contraction to complete before ventricular contraction

Propagatory Fibres

Main structures	Bundle of His and Purkinje fibres
Core role	Carry the depolarisation wave through the ventricles
Conduction property	Fast conduction
Mechanical consequence	Synchronous ventricular contraction
Common contrast	AV node delays conduction; His-Purkinje fibres rapidly propagate it

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Purkinje fibres are responsible for the conduction delay
- ✓ The AV node delays conduction; the Purkinje system conducts fast
- ✗ The bundle of His normally originates the cardiac cycle
- ✓ The SA node is the normal originator
- ✗ Fast His-Purkinje conduction exists to allow atrial filling time
- ✓ It produces synchronous, coordinated ventricular contraction

Basis of the ECG

- The ECG records voltage differences at the body surface, not mechanical contraction directly.
- Einthoven's triangle represents the three standard bipolar limb leads around the heart.
- Lead I runs from right arm to left arm.
- Lead II runs from right arm to left leg.
- Lead III runs from left arm to left leg.
- A deflection is positive when the net electrical vector moves towards the positive electrode of that lead.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ ECG leads are anatomical conducting fibres
- ✓ Leads are recording viewpoints; conducting fibres are SA node, AV node, bundle branches and Purkinje system
- ✗ Standard limb leads are unipolar
- ✓ Bipolar: each compares two electrodes (Einthoven's triangle)
- ✗ Lead I runs from left arm to left leg
- ✓ Lead I: right arm to left arm; Lead III: left arm to left leg

SA Node

SA node	Normal pacemaker and originator of the cardiac cycle
Sympathetic effect	Increases SA nodal firing rate and heart rate
Parasympathetic effect	Slows SA nodal firing rate and heart rate
Gap junctions	Permit spread of depolarisation between atrial myocytes

Desmosomes	Provide mechanical linkage between cardiac cells
Annulus fibrosus	Electrically separates atria and ventricles, directing conduction through the AV node

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The AV node starts the normal cardiac cycle
- ✓ The SA node starts it; the AV node delays and relays conduction
- ✗ Autonomic nerves generate each heartbeat in sinus rhythm
- ✓ They modulate SA nodal rate; the SA node itself generates each beat
- ✗ Atrioventricular conduction spreads across the whole AV border
- ✓ The annulus fibrosus insulates, channelling conduction through the AV node

Cardiac Cycle II – Pressures, Volumes and Events

Phases of the Cardiac Cycle

- Atrial systole follows the P wave and adds the final ~20% of ventricular filling.
- S1 is caused by mitral and tricuspid valve closure at the start of ventricular systole.
- During both isovolumetric phases, all valves are closed and ventricular volume is constant.
- Ventricular ejection occurs when ventricular pressure exceeds aortic or pulmonary arterial pressure.
- Peak ventricular pressures are approximately 120 mmHg in the left ventricle and 25 mmHg in the right ventricle.
- S2 is caused by aortic and pulmonary valve closure during ventricular relaxation.
- Ventricular filling occurs during the TP interval; S3 is associated with rapid early filling.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Valve opening produces S1 and S2
- ✓ Valve closure: S1 mitral/tricuspid, S2 aortic/pulmonary
- ✗ The QRS complex represents ventricular ejection
- ✓ QRS is electrical depolarisation; ejection follows once pressure opens the semilunar valves
- ✗ S3 occurs before S2
- ✓ S3 occurs during rapid ventricular filling, after S2

Cardiac Cycle III – Electrical Basis of Contractility

Effects of Inotropes

Positive inotropy in cardiac muscle usually means more effective calcium delivery to the contractile proteins. Catecholamines increase calcium release through beta-1-cAMP signalling. Digoxin increases calcium retention by reducing sodium-calcium exchange. Hypoxia reduces force because hydrogen ions interfere with calcium binding to troponin C, so the same calcium signal produces less contraction.

EXAM TRAPS × tempting option ✓ correct answer

- × Inotropy refers to heart rate
- ✓ Inotropy is force of contraction; chronotropy is heart rate
- × Digoxin directly opens calcium channels
- ✓ It inhibits Na-K ATPase, reducing NCX calcium removal, so intracellular calcium rises
- × Hypoxia increases myocardial contractility
- ✓ Reduces it: H⁺ (acidosis) impairs calcium binding to troponin C

Excitation-Contraction Coupling

Trigger for contraction	Ca ²⁺ entry through L-type channels during phase 2 of the cardiac action potential.
Main release mechanism	Calcium-induced calcium release from the sarcoplasmic reticulum.
Contractile target	Ca ²⁺ binds troponin C, permitting actin-myosin cross-bridge cycling.
Main reuptake pathway	SERCA pumps Ca ²⁺ back into the sarcoplasmic reticulum.
Main extrusion pathway	NCX removes Ca ²⁺ from the cell.
Treppe effect	Increasing heart rate can increase contractility through progressive intracellular Ca ²⁺ accumulation.

EXAM TRAPS × tempting option ✓ correct answer

- × Extracellular calcium provides all the calcium for cardiac contraction
- ✓ It mainly triggers calcium-induced calcium release from the sarcoplasmic reticulum
- × Cardiac muscle, like skeletal, does not require extracellular calcium entry
- ✓ Cardiac excitation-contraction coupling requires L-type Ca²⁺ entry in phase 2
- × NCX returns calcium to the sarcoplasmic reticulum
- ✓ SERCA returns it to the SR; NCX removes calcium from the cell

Myocyte Action Potential

Resting potential	Approximately -85 to -90 mV
Threshold potential	Approximately -65 mV
Phase 0	Fast Na ⁺ influx causes rapid depolarisation
Phase 1	Brief repolarisation after Na ⁺ channel inactivation
Phase 2	L-type Ca ²⁺ influx creates plateau; maintains contraction and prevents tetany
Phase 3	K ⁺ efflux causes rapid repolarisation
Phase 4	Stable resting membrane potential in working myocytes

EXAM TRAPS × tempting option ✓ correct answer

- × Ventricular and SA node phase 0 are both fast Na⁺ mediated
- ✓ Ventricular phase 0 is fast Na⁺; nodal depolarisation is slower and calcium-dependent
- × The plateau phase is shared by skeletal muscle and allows tetany
- ✓ Plateau is a cardiac feature that prevents tetany
- × Phase 3 is the plateau of the ventricular action potential
- ✓ Phase 2 is plateau; phase 3 repolarisation; phase 4 resting potential

SA Node Action Potential

Fast Na⁺ channels	Absent in SA node pacemaker cells
Phase 4	Spontaneous pacemaker depolarisation
Funny current, I_f	Slow inward depolarising current, mainly Na ⁺
K⁺ current	Progressive decay of K ⁺ efflux helps depolarisation; increased K ⁺ conductance slows rate
Positive chronotropes	Increase I _f , steepen phase 4 and increase heart rate
Negative chronotropes	Slow phase 4 and decrease heart rate

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ SA node phase 4 is a stable resting membrane potential
- ✓ SA node phase 4 is spontaneous depolarisation; stable phase 4 is in ventricular myocytes
- ✗ SA node phase 0 is caused by fast Na⁺ influx
- ✓ SA node lacks fast Na⁺ channels, so depolarisation is slower
- ✗ Positive chronotropes flatten the pacemaker potential
- ✓ They steepen phase 4; negative chronotropes flatten it

Cardiac Output

Cardiac Output and Its Determinants

Equation	CO = HR × SV.
Frank-Starling mechanism	Increased EDV/preload increases stretch and force of contraction up to a limit.
Starling curve	Ascending limb: useful increase in SV; plateau: little extra SV despite more filling.
Pulmonary oedema	Occurs when LV filling exceeds LV ejection capacity, raising pulmonary venous and capillary pressure.
Standing response	Venous pooling lowers CVP and CO; baroreceptors trigger sympathetic correction.
Afterload	Higher afterload reduces SV for the same EDV and can drive higher filling pressures and eventual failure.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Increasing preload always increases cardiac output
- ✓ Beyond the Starling plateau, extra filling mainly raises pressure, not output
- ✗ Contractility and preload are the same thing
- ✓ Contractility is force at a given fibre length; preload is stretch before contraction
- ✗ Standing causes a fall in output from primary myocardial failure
- ✓ Venous pooling reduces venous return and CVP

Peripheral Vascular Physiology I

Basis of Vasoconstriction

Core pathway	Alpha-1 → G _q → IP ₃ → Ca ²⁺ release from SR → smooth muscle contraction
Key ion	Calcium is the final common intracellular signal for contraction
Main vascular effect	Reduced vessel radius and increased resistance
Calcium-channel blockers	Block L-type calcium channels → reduced Ca ²⁺ entry → vasodilation

Cardiac implication	Reduced L-type calcium entry in cardiac myocytes can reduce contractility
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ Alpha-1 stimulation causes vasodilation in skeletal muscle beds
- ✓ Alpha-1 causes vasoconstriction; beta-2 tends to cause skeletal muscle vasodilation
- ✗ Vascular smooth muscle contraction depends on fast Na⁺ influx
- ✓ It depends on intracellular Ca²⁺ (alpha-1, Gq, IP3 pathway)

Endothelial Function

Endothelial role	Source of vasoactive mediators that regulate vascular smooth muscle tone
Main vasodilators	Nitric oxide (NO), prostacyclin (PGI ₂)
Main vasoconstrictors	Endothelin-1, thromboxane A ₂
Stimuli to secretion	Shear stress, hypoxia, inflammatory cytokines, acetylcholine

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The endothelium is a passive lining with no effect on tone
- ✓ It actively releases mediators (NO, PGI₂, endothelin-1, thromboxane A₂) altering tone
- ✗ Prostacyclin is a vasoconstrictor
- ✓ Prostacyclin favours vasodilation; thromboxane A₂ favours vasoconstriction
- ✗ Acetylcholine vasodilates even with damaged endothelium
- ✓ Acetylcholine-mediated vasodilation depends on an intact endothelium

Peripheral Vascular Physiology II

Filtration (Starling Forces at Capillaries)

Capillary hydrostatic pressure	Pushes fluid out of the capillary; favours filtration.
Interstitial oncotic pressure	Draws fluid out of the capillary; favours filtration.
Plasma oncotic pressure	Draws fluid into the capillary; favours reabsorption.
Arteriolar end	Net filtration because hydrostatic pressure is relatively high.
Venular end	Net reabsorption in the classical model because oncotic pressure predominates.
Lymphatics	Return excess filtered fluid and protein to the circulation.
Oedema mechanisms	Capillary leak, low oncotic pressure, high venous pressure, or inadequate lymphatic return.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oncotic pressure pushes fluid out of capillaries
- ✓ Hydrostatic pressure pushes; oncotic pressure pulls water towards proteins
- ✗ Low albumin causes oedema by increasing capillary pressure
- ✓ Low albumin reduces plasma oncotic pressure, reducing reabsorption
- ✗ High venous pressure does not cause oedema
- ✓ It raises capillary hydrostatic pressure and favours filtration

Microcirculation Structure

Inflow control	Terminal arterioles
Exchange segment	Capillaries
Interstitial fluid return	Lymphatic capillaries
Initial venous drainage	Postcapillary venules
Return towards larger veins	Venules

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Venules are the final control vessels before capillary exchange
- ✓ Terminal arterioles are the final small arterial control vessels before capillaries

Transcapillary Exchange

Transcapillary exchange	Movement of substances between capillary blood and interstitial fluid
Lipophilic substances	Move directly through the endothelial membrane bilayer
Hydrophilic substances	Move through aqueous pores/channels or paracellular pathways
Tight junctions	Control passage between endothelial cells
Glycocalyx	Contributes to selective filtering at the endothelial surface
Pores	Provide water-filled routes for small hydrophilic solutes

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × All substances cross capillaries by the same route
- ✓ Lipid-soluble cross the bilayer; water-soluble use aqueous pores or paracellular routes
- × Hydrophilic substances cross capillaries through the lipid bilayer
- ✓ They need aqueous pathways: pores, channels or paracellular routes
- × Solute diffusion across capillaries is driven by Starling forces
- ✓ Starling forces drive bulk filtration of water; solutes cross mainly by diffusion

Peripheral Vascular Physiology III

Brain Circulation

Blood-brain barrier components	Tight endothelial junctions, astrocyte foot processes and pericytes
Main cerebral vasodilator	CO ₂ , acting through H ⁺ and pH changes
Effect of increased CO₂	Cerebral vasodilation and increased cerebral blood flow
Role of potassium	Rises during neuronal activity and promotes local vasodilation
Physiological purpose	Matches blood flow to local metabolic demand

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Cerebral blood flow is purely pressure-dependent
- ✓ Local metabolic factors (CO₂/H⁺, K⁺) are central to regulation
- × Potassium in cerebral flow acts as a systemic reflex signal
- ✓ It is a local signal of neuronal activity, promoting local vasodilation

Coronary Flow

Main control mechanism	Local metabolic hyperaemia of coronary arterioles
Resting oxygen extraction	Approximately 70%, the highest of any organ
Response to increased demand	Increase coronary flow rather than greatly increasing extraction
Important vasodilator	Adenosine
Timing of LV coronary flow	Predominantly during diastole

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The heart meets increased demand mainly by increasing oxygen extraction
- ✓ Extraction is already ~70% at rest; demand is met by increasing coronary flow
- ✗ Left ventricular coronary flow occurs mainly in systole
- ✓ Mainly in diastole
- ✗ Tachycardia improves coronary perfusion
- ✓ It raises oxygen demand and shortens diastolic perfusion time

Cutaneous Flow

Main role of cutaneous flow	Thermoregulation, in addition to skin nutrition.
Arteriovenous anastomoses	Direct arteriolar-venular channels that regulate heat transfer.
Cold response	Vasoconstriction and reduced skin perfusion conserve heat.
Heat response	Vasodilation and increased superficial flow promote heat loss.
Inflammation	Local vasodilator mediators increase regional flow, causing redness and warmth.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Skin blood flow is regulated mainly by metabolic demand
- ✓ Skin flow is strongly shaped by thermoregulatory need
- ✗ Arteriovenous anastomoses mainly serve nutrient exchange
- ✓ They bypass capillaries; their key role is heat transfer
- ✗ Inflammatory redness and warmth reflect systemic vasodilation
- ✓ Regional effect of local vasodilator mediators

Local Control of Blood Flow

Autoregulation range	Approximately 60-150 mmHg
Myogenic response	Stretch of arteriole causes vasoconstriction
Low pressure response	Reduced stretch allows vasodilation
Metabolic hyperaemia	Local increase in flow caused by metabolic vasodilators
Key vasodilators	K ⁺ , CO ₂ and adenosine

EXAM TRAPS × tempting option ✓ correct answer

- × CO₂ causes vasoconstriction in most systemic tissues
- ✓ CO₂ is a systemic vasodilator; hypoxic pulmonary vasoconstriction is a separate special case
- × Autoregulation maintains constant flow at all pressures
- ✓ Only within approximately 60–150 mmHg; outside it flow becomes pressure-dependent
- × The myogenic response is primarily neurally mediated
- ✓ It is local and intrinsic to vascular smooth muscle

Pulmonary Flow

Pulmonary response to hypoxia	Arteriolar constriction.
Contrast with systemic circulation	Systemic local hypoxia usually causes vasodilatation.
Name of mechanism	Hypoxic pulmonary vasoconstriction.
Purpose	Diverts blood away from poorly ventilated alveoli.
Physiological result	Optimises V/Q matching.

EXAM TRAPS × tempting option ✓ correct answer

- × Alveolar hypoxia causes pulmonary arteriolar vasodilatation
- ✓ Pulmonary arterioles constrict (HPV); systemic tissues dilate to hypoxia
- × Hypoxic pulmonary vasoconstriction is primarily a whole-body reflex
- ✓ It is local redistribution of flow within the lung to optimise V/Q matching

Skeletal Muscle Flow

Metabolic hyperaemia	Increased local blood flow driven by increased tissue metabolism
Capillary recruitment	Perfusion of more capillaries in active muscle, improving exchange
Local vasodilators	K ⁺ , CO ₂ , H ⁺ , adenosine and low O ₂ in active systemic muscle
Systemic importance	Skeletal muscle vascular beds are the largest contributor to total peripheral resistance at rest
Exam principle	Active muscle flow rises locally, while resting muscle tone helps maintain systemic resistance

EXAM TRAPS × tempting option ✓ correct answer

- × Capillary recruitment means formation of new capillaries
- ✓ Increased perfusion of existing capillaries
- × Sympathetic tone alone determines skeletal muscle flow
- ✓ Local metabolic factors can dominate in active muscle

Gastrointestinal Physiology

Functional Anatomy of the GI Tract

Outline Structure of the Gut Wall

Auerbach's plexus	Between longitudinal and circular muscle; motility
Meissner's plexus	In submucosa; secretion and mucosal activity
Muscularis externa	Longitudinal + circular smooth muscle layers
Mucosa	Muscularis mucosae + lamina propria + epithelium

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ In the gut wall the circular muscle layer lies outside the longitudinal
- ✓ Longitudinal is outer; circular is inner
- ✗ Meissner's plexus lies between the two muscle layers
- ✓ Auerbach's lies between muscle layers; Meissner's is in the submucosa
- ✗ The mucosa is a single epithelial layer
- ✓ Compound layer: epithelium, lamina propria and muscularis mucosae

Saliva

Salivary Glands and Saliva

Production sites	Parotid, submandibular and sublingual glands
Digestive enzyme	Salivary amylase begins carbohydrate digestion
Antimicrobial factors	IgA and lysozyme
Lubricating component	Mucus
Taste function	Saliva dissolves molecules so they can stimulate taste receptors
pH role	Buffers oral pH
Main stimuli	Taste and smell
Autonomic control	Parasympathetic: copious watery; sympathetic: scant, viscous, protein-rich

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Only parasympathetic innervation stimulates salivary secretion
- ✓ Both stimulate: parasympathetic copious watery; sympathetic scant, viscous, protein-rich
- ✗ Saliva's only function is digestion
- ✓ Also protective (IgA, lysozyme), taste, lubrication (mucus) and buffering
- ✗ Saliva begins major fat and protein digestion
- ✓ Salivary amylase starts carbohydrate digestion only

Swallowing

Phases of Swallowing

Voluntary phase	Tongue propels bolus to oropharynx.
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Pharyngeal reflex	Soft palate elevates; larynx rises; epiglottis closes laryngeal inlet; UOS relaxes.
Oesophageal phase	Peristaltic wave propels bolus distally; LOS relaxes.
UOS	Prevents air swallowing and helps prevent aspiration.
LOS	Prevents gastro-oesophageal reflux.
Peristalsis	Sequential contraction and relaxation moves luminal contents distally.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The pharyngeal phase of swallowing is voluntary
- ✓ Only the oral phase is voluntary; the pharyngeal phase is reflex
- ✗ Peristalsis is simultaneous contraction of the whole oesophagus
- ✓ Coordinated wave: contraction behind and relaxation ahead of the bolus

Stomach Physiology

Chyme Production and Gastric Emptying

Chyme production	Mixing waves and gastric secretions create acidic semi-fluid chyme.
Pyloric sphincter	Controls delivery to the duodenum and prevents large particles leaving the stomach.
Acid in duodenum	Inhibits emptying, especially through secretin-mediated responses.
Fats	Slow emptying via CCK release.
Distension	Promotes emptying up to a physiological limit.
Osmolarity	Duodenal contents that are too osmotically concentrated slow emptying.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Gastric emptying is determined only by gastric peristalsis
- ✓ Duodenal feedback (acid, fat via CCK, osmolarity) is central
- ✗ The pylorus is a simple open-or-closed valve
- ✓ It regulates flow and particle size, preventing large particles leaving

Functions of the Stomach

Storage	Receptive relaxation via vagal reflexes allows meal accommodation.
Digestion	HCl provides acidity; pepsin begins protein digestion.
Chyme regulation	Mixing and pyloric control provide gradual duodenal delivery.
Intrinsic factor	Required for vitamin B12 absorption in the terminal ileum.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The stomach is a main site of nutrient absorption
- ✓ Its key absorptive contribution is intrinsic factor, enabling B12 absorption in terminal ileum
- ✗ The pylorus has no role in chyme regulation
- ✓ The pylorus is central to controlled duodenal delivery
- ✗ Pepsinogen is the active enzyme digesting protein
- ✓ Pepsin is the active enzyme; pepsinogen is the inactive precursor

Gastric Secretory Cells

Chief cells	Secrete pepsinogen.
Pepsinogen activation	Activated to pepsin by HCl.
Parietal cells	Secrete HCl and intrinsic factor.
Proton pump	H-K-ATPase secretes H ⁺ into the lumen in exchange for K ⁺ ; target of PPIs.
Mucosal protection	Mucus, bicarbonate, tight junctions and rapid cell turnover protect against acid-pepsin injury.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Chief cells secrete active pepsin
- ✓ Chief cells secrete pepsinogen, activated to pepsin by HCl
- ✗ Chief cells produce intrinsic factor
- ✓ Parietal cells produce intrinsic factor as well as HCl
- ✗ PPIs act by inhibiting pepsinogen
- ✓ PPIs inhibit the H-K-ATPase final pathway
- ✗ The mucus layer alone protects the gastric mucosa
- ✓ Bicarbonate, tight junctions and rapid cell turnover are also required

Secretion Patterns and Their Stimuli

Phase	Exam trigger phrase	Essential answer
Cephalic	Sight, smell, taste, thought	Vagus-mediated; about 30% of gastric secretion.
Gastric	Distension or protein in stomach	Gastrin from antral G cells plus vagal reflexes; about 60%.
Intestinal	Chyme in duodenum	Initially intestinal gastrin, then inhibitory feedback; about 10%.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The cephalic phase requires food in the stomach
- ✓ Triggered before gastric filling by sight, smell, taste, thought (vagus)
- ✗ The cephalic phase is the largest contributor to gastric secretion
- ✓ Gastric phase, about 60%; cephalic about 30%
- ✗ The intestinal phase is purely stimulatory
- ✓ Initially stimulatory, then inhibitory as duodenal feedback develops

Small Intestine Physiology

Duodenal Environment

Incoming chyme	Acidic, partially digested gastric contents
Water	Dilutes chyme and assists mixing
Bicarbonate	Neutralises acid; supports pH around 7
Bile	Emulsifies fat droplets
Main functional result	Optimal environment for pancreatic enzyme activity

EXAM TRAPS × tempting option ✓ correct answer

- × Bile digests fat directly
- ✓ Bile emulsifies fat; pancreatic lipase performs enzymatic digestion
- × Pancreatic enzymes work optimally at acidic gastric pH
- ✓ Duodenal bicarbonate shifts pH towards approximately 7 for enzyme activity
- × Water added in the duodenum serves no functional purpose
- ✓ It dilutes chyme and assists mixing

Duodenal Regulation

Trigger in duodenum	Hormonal response	Physiological result
Acidic chyme	Secretin from S cells	Less gastric acid secretion; more pancreatic bicarbonate.
Fats and proteins	CCK from I cells	Slower gastric emptying.
Excessive duodenal load	Duodenal inhibitory feedback	More controlled delivery of chyme to the small intestine.

EXAM TRAPS × tempting option ✓ correct answer

- × Secretin is released in response to fats and proteins
- ✓ Secretin responds to acid; CCK responds to fats and proteins
- × Secretin acts only on the pancreas
- ✓ It also inhibits gastric acid secretion
- × CCK accelerates gastric emptying
- ✓ CCK slows gastric emptying
- × Duodenal feedback is not needed to regulate chyme delivery
- ✓ It protects the duodenum from excess acid and uncontrolled chyme delivery

Intestinal Absorption Mechanisms

Villi and microvilli	Increase surface area for absorption
Central lacteal	Receives absorbed lipid as chylomicrons
Capillary network	Receives most non-lipid absorbed nutrients
Na-K ATPase	Creates sodium gradient that drives secondary active transport
Glucose and galactose	Absorbed with Na ⁺ via SGLT1
Fructose	Absorbed by facilitated diffusion via GLUT5
Proteases	Cleave peptide bonds; carboxypeptidase removes C-terminal amino acids
Calcium	Active absorption via Ca-ATPase, regulated by vitamin D
Iron	Vitamin C improves absorption by reducing Fe ³⁺ to Fe ²⁺ ; DMT1 and ferroportin are key carriers
Fats	Emulsification, micelles, enterocyte uptake, triglyceride reassembly, chylomicrons, lacteals

EXAM TRAPS × tempting option ✓ correct answer

- × Absorbed fats enter the capillary network of the villus
- ✓ Fats enter lacteals as chylomicrons; most other nutrients enter capillaries
- × Glucose is absorbed via SGLT1 by simple diffusion

- ✓ Sodium-linked secondary active transport, driven by Na-K ATPase gradient
- ✗ Fructose is absorbed via SGLT1 with sodium
- ✓ Fructose uses facilitated diffusion via GLUT5
- ✗ Vitamin C impairs iron absorption
- ✓ Improves it by reducing Fe^{3+} to the better-absorbed Fe^{2+}
- ✗ Vitamins A, D, E and K are unaffected by impaired fat absorption
- ✓ Fat-soluble vitamins follow lipid absorption, so fat malabsorption impairs them

Pancreatic Physiology

Exocrine Pancreatic Secretion

Ductal secretion	Water and bicarbonate
Main ductal stimulus	Secretin
Acinar secretion	Digestive enzymes
Protease examples	Trypsinogen, chymotrypsinogen, proelastase
Protease safety mechanism	Secreted as inactive proenzymes; activated in the duodenum
Fat digestion enzymes	Lipase and colipase
Carbohydrate digestion enzyme	Amylase
Nucleic acid digestion enzymes	Nucleases

⚠ EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ Pancreatic bicarbonate is mainly secreted by acinar cells
- ✓ Bicarbonate is ductal; digestive enzymes are acinar
- ✗ Pancreatic proteases are secreted in active form
- ✓ Secreted as inactive proenzymes, activated in the duodenum
- ✗ Pancreatic bicarbonate is a digestive enzyme
- ✓ It neutralises gastric acid and supports enzyme activity

Pancreatic Hormonal Control

CCK origin	I cells of duodenum and jejunum
CCK action	Pancreatic enzyme secretion; gallbladder contraction; sphincter of Oddi relaxation
Secretin origin	S cells of duodenum
Secretin action	Pancreatic bicarbonate secretion to neutralise acid chyme
Core distinction	CCK = enzymes and bile delivery; secretin = bicarbonate and acid neutralisation

⚠ EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ CCK is secreted by S cells
- ✓ CCK from I cells; secretin from S cells
- ✗ Secretin mainly stimulates pancreatic enzyme secretion
- ✓ Secretin stimulates bicarbonate; CCK stimulates enzyme secretion
- ✗ CCK contracts the sphincter of Oddi
- ✓ CCK contracts the gallbladder and relaxes the sphincter of Oddi

Liver Physiology

Enterohepatic Circulation

Main concept	Recycling of bile salts between liver, intestine and portal circulation
Initial source	Bile is secreted by the liver
Storage site	Gallbladder
Release into gut	Bile enters the duodenum after CCK stimulation
Small intestinal role	Bile salts emulsify fats
Reabsorption site	Terminal ileum
Amount reabsorbed	Approximately 95% of bile salts
Return pathway	Portal vein back to the liver for re-secretion
Clinical interruption	Terminal ileal disease or resection
Clinical consequence	Bile salt malabsorption leading to fat malabsorption and steatorrhoea

 **EXAM TRAPS** x tempting option ✓ correct answer

- ✗ The gallbladder produces bile
- ✓ The liver secretes bile; the gallbladder stores it
- ✗ Bile salts are mainly reabsorbed in the jejunum
- ✓ Terminal ileum (~95% reabsorbed), returning via the portal vein

Hepatic Bile

Origin	Hepatic bile is produced by hepatocytes.
Primary bile salts	Derived from cholic acid and chenodeoxycholic acid.
Major listed constituents	Bile salts, cholesterol, bilirubin, phospholipids, water and electrolytes.
Main digestive role	Bile salts support fat emulsification and micelle formation.
Main excretory role	Bile carries bilirubin and cholesterol into the biliary tract.

 **EXAM TRAPS** x tempting option ✓ correct answer

- ✗ Hepatic bile is produced by the gallbladder
- ✓ Hepatocytes produce it; the gallbladder stores and concentrates it
- ✗ Bile is purely a digestive secretion
- ✓ It also excretes bilirubin and cholesterol
- ✗ Cholesterol in bile is always pathological
- ✓ Cholesterol is a normal constituent of bile

Portal Triad Structure

The portal triad lies at the periphery of the lobule, while the central vein lies centrally. This creates the classic lobular pattern: blood flows from portal triad to central vein, whereas bile flows from hepatocytes towards the portal triad. This opposite direction of blood and bile flow is a common conceptual anchor for understanding liver physiology.

Portal triad components	Portal vein branch, hepatic artery branch, bile ductule
Blood flow direction	From portal triad into sinusoids, then towards central vein

Bile flow direction	From hepatocytes towards bile ductules at the portal triad
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ The bile ductule of the portal triad carries blood
- ✓ It carries bile; the portal vein and hepatic artery branches carry blood
- ✗ The central vein is part of the portal triad
- ✓ It is separate, at the centre of the classical lobule
- ✗ Blood and bile flow in the same direction within the lobule
- ✓ Blood flows towards the central vein; bile flows towards the portal triad

Gallbladder Physiology

Gallbladder Functions

Main gallbladder role	Stores and concentrates hepatic bile.
Concentration mechanism	Active Na ⁺ absorption followed by osmotic water movement.
Degree of concentration	Approximately 5- to 10-fold.
Key release hormone	CCK.
CCK actions	Gallbladder contraction plus sphincter of Oddi relaxation.
Neural contribution	Vagal stimulation supports bile release during digestion.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The gallbladder produces bile
- ✓ Hepatocytes produce bile; the gallbladder stores and concentrates it 5- to 10-fold
- ✗ CCK causes gallbladder contraction and sphincter of Oddi contraction
- ✓ Gallbladder contraction plus sphincter of Oddi relaxation
- ✗ Secretin is the key signal for gallbladder emptying
- ✓ CCK drives emptying; bile salts and secretin stimulate bile formation

Large Intestine Physiology

Large Intestinal Functions

Function	Key physiological mechanism	Essential exam point
Entry from ileum	Ileocaecal sphincter controlled by reflexes and pressure gradients	Gastric distension promotes ileal emptying via the gastroileal reflex
Segmentation	Taeniae coli and haustral contractions	Mixing increases mucosal contact time
Propulsion	Peristalsis and mass movements	Mass movement is a strong propulsive wave triggered by GI distension
Water absorption	Active Na ⁺ absorption via Na-K ATPase; water follows osmotically	Sodium movement drives water reclamation
Bacterial processing	Colonic microbiome metabolises residual material	Vitamin K, biotin and folate synthesis; bile pigment handling
Defecation	Rectal distension activates S2-S4 spinal reflex	Internal sphincter relaxes; external sphincter is voluntary via pudendal nerve

EXAM TRAPS × tempting option ✓ correct answer

- × Mass movements are the local mixing contractions of the colon
- ✓ Haustral contractions mix locally; mass movement is a stronger propulsive wave
- × Colonic water absorption occurs independently of sodium transport
- ✓ Driven by active Na⁺ absorption (Na-K ATPase); water follows the osmotic gradient
- × The gastroileal reflex triggers colonic mass movements
- ✓ Gastroileal reflex opens the ileocaecal sphincter; gastrocolic reflex triggers colonic mass movements

PHYSIOLOGY · TOPIC 5 OF 6

Renal Physiology

Functional Anatomy of the Renal Tract

Macroscopic Structure of the Kidney

Cortex	Contains glomeruli plus proximal and distal convoluted tubules.
Medulla	Contains loops of Henle and collecting ducts.
Renal pyramids	Medullary units whose papillae drain into minor calyces.
Renal columns	Cortical extensions between medullary pyramids.
Urine outflow	Papillae → minor calyces → major calyces → renal pelvis → ureter.

EXAM TRAPS × tempting option ✓ correct answer

- × Glomeruli lie in the renal medulla
- ✓ Glomeruli are cortical structures
- × Proximal and distal convoluted tubules lie mainly in the medulla
- ✓ Convoluted tubules are mainly cortical; loops of Henle pass into the medulla
- × Renal papillae drain directly into the renal pelvis
- ✓ Papillae → minor calyces → major calyces → renal pelvis → ureter

Renal Blood Supply and Drainage

Renal blood flow	Approximately 20% of resting cardiac output.
Glomerular inflow	Afferent arteriole.
Glomerular outflow	Efferent arteriole.
Cortical post-glomerular vessels	Peritubular capillaries.
Medullary post-glomerular vessels	Vasa recta.
Autoregulation range	Stable GFR across MAP ~80-180 mmHg.
Autoregulatory mechanisms	Myogenic response and tubuloglomerular feedback at the macula densa.
Lymph drainage	Para-aortic lymph nodes.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The glomerular capillaries lie between an arteriole and a venule
- ✓ Glomerulus lies between two arterioles: afferent in, efferent out
- × Vasa recta mainly supply the cortical tubules
- ✓ Peritubular capillaries serve cortical tubules; vasa recta descend into the medulla
- × GFR changes directly with every small change in blood pressure
- ✓ Autoregulation keeps GFR stable across MAP ~80-180 mmHg
- × Tubuloglomerular feedback is sensed in the proximal tubule
- ✓ Sensed at the macula densa

The Nephron

Bowman's capsule	Ultrafiltration
Proximal tubule	Bulk reabsorption: Na ⁺ , glucose, amino acids, HCO ₃ ⁻ , H ₂ O and urea
Loop of Henle	Counter-current multiplication; medullary concentration gradient
Distal tubule	Fine-tuning of Na ⁺ , K ⁺ and Ca ²⁺ ; hormone-regulated
Collecting duct	ADH-dependent water reabsorption; acid-base role

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Glomeruli are located in the renal medulla
- ✓ Glomeruli are cortical structures
- × The proximal tubule is the hormone-regulated fine-tuning segment
- ✓ Proximal tubule performs bulk reabsorption; fine-tuning occurs distally
- × The collecting duct creates the medullary concentration gradient
- ✓ Loop of Henle creates the gradient; collecting duct uses it under ADH influence
- × The collecting duct has no role in acid-base handling
- ✓ Collecting duct performs ADH-dependent water reabsorption and has an acid-base role

Mechanism of Filtration in Health

Creatinine Clearance

Purpose	Creatinine clearance estimates glomerular filtration.
Why creatinine works	It is freely filtered, not reabsorbed and only minimally secreted.
Source	Endogenous production from muscle metabolism is relatively constant.
Equation	$\text{Clearance} = (C_u \times V) / C_p$
Units	Usually expressed as volume per unit time, typically mL/min.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Creatinine clearance equals the urine flow rate
- ✓ Clearance is the plasma volume cleared per unit time, not urine volume produced
- × Urinary creatinine excretion alone determines clearance
- ✓ $\text{Clearance} = (C_u \times V) / C_p$; plasma concentration changes the meaning of the same excretion rate
- × Creatinine clearance is an exact measure of GFR
- ✓ It approximates GFR; minimal tubular secretion of creatinine makes it imperfect

Glomerular Filtration

Normal GFR	~125 mL/min or ~180 L/day
Urine excreted	~1.5 L/day after tubular handling
Filtration fraction	~20%
Barrier layers	Fenestrated endothelium, GBM, podocyte slits
Force increasing GFR	Glomerular capillary hydrostatic pressure
Forces decreasing GFR	Plasma oncotic pressure and Bowman's capsule hydrostatic pressure
Afferent constriction	Decreases GFR
Efferent constriction	Increases GFR up to a point

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × About 180 L/day of urine is normally excreted
- ✓ ~180 L/day is filtered; only ~1.5 L/day is excreted
- × Plasma oncotic pressure favours glomerular filtration
- ✓ It opposes filtration because plasma proteins remain within the capillary
- × Efferent arteriolar constriction lowers GFR
- ✓ Efferent constriction initially raises GFR; afferent constriction lowers it
- × Prostaglandins play no part in maintaining afferent arteriolar flow
- ✓ Prostaglandins protect afferent arteriolar flow, particularly under physiological stress

Tubular Transport

Maximal Tubular Transport (T_m) and Glucose Threshold

Transport maximum (T_m)	Maximum carrier-mediated transport rate; all carriers occupied at saturation
Glucose threshold	Plasma glucose above which glucosuria occurs; about 10 mmol/L or 180 mg/dL
Glucosuria	Occurs when filtered glucose exceeds effective reabsorptive capacity
Splay	Early/gradual glucose spill before complete saturation due to nephron heterogeneity
Main site for glucose reabsorption	Proximal tubule via sodium-glucose co-transporters

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Glucosuria begins abruptly at an exact plasma glucose threshold
- ✓ Splay from nephron heterogeneity makes glucose excretion begin gradually
- × The renal glucose threshold is about 7 mmol/L
- ✓ Approximately 10 mmol/L (180 mg/dL)
- × The glucose threshold is the maximal tubular transport rate
- ✓ Threshold is a plasma concentration; T_m is a maximum transport rate
- × Carrier-mediated tubular transport has unlimited capacity
- ✓ It saturates (T_m) when all carriers are occupied

Modes of Tubular Transport

Paracellular	Between cells via tight junctions
Transcellular	Through cells via membrane transporters

Primary active transport	Direct ATP use, e.g. Na-K ATPase
Secondary active transport	Uses Na ⁺ gradient created by Na-K ATPase
Classic example	SGLT co-transporter reabsorbs glucose with sodium

EXAM TRAPS × tempting option ✓ correct answer

- ✗ SGLT is a primary active transporter
- ✓ Secondary active: uses the Na⁺ gradient; the transporter itself does not directly use ATP
- ✗ Tubular Na-K ATPase is on the apical (luminal) membrane
- ✓ Usually basolateral; maintains the Na⁺ gradient driving many apical transport processes
- ✗ Paracellular transport passes through the tubular cells
- ✓ Paracellular is between cells via tight junctions; transcellular is through cells

Proximal Tubular Function

Proximal Tubule Reabsorption

Main role	Bulk reabsorption of filtered solute and water
Key driving pump	Basolateral Na-K ATPase
Sodium	~65% reabsorbed
Glucose	Normally 100% reabsorbed, mainly via SGLT2 in the early proximal tubule and SGLT1 later
Amino acids	Normally 100% reabsorbed with sodium co-transport
Bicarbonate	~85% reabsorbed via carbonic anhydrase-dependent CO ₂ handling
Water	~65% reabsorbed osmotically
Urea	~50% reabsorbed passively

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Proximal tubular glucose reabsorption is simple diffusion
- ✓ Sodium-dependent secondary active transport (SGLT2 early, SGLT1 later)
- ✗ The proximal tubule Na-K ATPase is on the luminal membrane
- ✓ It is basolateral
- ✗ Filtered bicarbonate crosses the apical membrane unchanged
- ✓ Reclaimed via CO₂ formation (carbonic anhydrase) and regeneration of HCO₃⁻ inside the cell
- ✗ ADH, aldosterone and PTH mainly act on the proximal tubule
- ✓ Proximal tubule does bulk reabsorption; these hormones fine-tune distally

Loop of Henle

Loop of Henle Function

Descending limb	Water permeable; solute relatively impermeable; concentrates tubular fluid.
Thick ascending limb	Water impermeable; actively transports NaCl out; dilutes tubular fluid.
Counter-current multiplier	Uses opposite flow and different limb permeability to amplify the medullary gradient.
Medullary osmolality	Highest near papilla, approximately 1200 mOsm/kg.

Loop diuretics	Block NKCC2 in thick ascending limb; disrupt concentrating ability and cause large diuresis.
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⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The thick ascending limb is permeable to water
- ✓ Descending limb loses water; thick ascending limb loses salt but not water
- ✗ The thick ascending limb concentrates tubular fluid
- ✓ It dilutes tubular fluid while simultaneously increasing medullary osmolality
- ✗ The loop of Henle alone determines final urine concentration
- ✓ Loop creates the gradient; ADH-regulated collecting duct water permeability determines water reabsorption
- ✗ Furosemide acts mainly on the distal convoluted tubule
- ✓ Blocks NKCC2 in the thick ascending limb

Distal Collecting System

Distal Tubule and Collecting Duct

Collecting duct without ADH	Low water permeability; dilute urine.
Collecting duct with ADH	AQP2 insertion; water reabsorption; concentrated urine.
Urea handling	ADH increases urea permeability in the inner medullary collecting duct.
Medullary osmolality	Maintained partly by urea recycling; provides the gradient for water reabsorption.
Potassium and flow	Higher tubular flow increases K ⁺ loss; diuretics may cause hypokalaemia.
Calcium handling	PTH increases distal tubular Ca ²⁺ reabsorption; activated vitamin D increases Ca ²⁺ absorption in gut and kidney.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ ADH creates the medullary concentration gradient
- ✓ Loop of Henle creates the gradient; ADH lets the collecting duct use it
- ✗ Urea is purely a waste product with no role in concentrating urine
- ✓ Urea recycling contributes to inner medullary osmolality

Regulation of Plasma Osmolality

Osmolality Regulation Overview

Normal plasma osmolality	Approximately 285 mOsm/kg
Main sensor	Hypothalamic osmoreceptors
Trigger for ADH release	Rise in plasma osmolality
ADH source	Posterior pituitary release of hypothalamically produced ADH
Renal receptor	V2 receptor
Renal effect	Increased collecting duct water reabsorption
Systemic receptor	V1 receptor
Systemic effect	Vasoconstriction at high ADH concentrations
Additional response	Thirst
ADH metabolism	Liver and kidney

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Raised osmolality is corrected mainly by rapid sodium excretion
- ✓ Osmolality is corrected mainly by changing water handling (ADH, thirst)
- ✗ Thirst is merely a symptom, not part of osmoregulation
- ✓ Thirst is part of the physiological response to raised osmolality
- ✗ ADH acts on V1 receptors to increase renal water reabsorption
- ✓ V2 mediates renal water reabsorption; V1 mediates vasoconstriction
- ✗ Once released, ADH acts indefinitely
- ✓ Negative feedback and rapid hepatic and renal metabolism allow precise control

Effects of Renal Hormones

Aldosterone and ANP

Aldosterone target	Principal cells of the collecting duct
Aldosterone sodium effect	Increases Na ⁺ reabsorption via ENaC
Aldosterone potassium effect	Increases K ⁺ secretion
Net aldosterone effect	Na ⁺ and water retention with K ⁺ loss
ANP release stimulus	Atrial stretch due to volume overload
ANP endocrine effect	Inhibits renin, aldosterone and ADH release
ANP renal vascular effect	Dilates afferent arterioles, increasing GFR
Net ANP effect	Natriuresis: Na ⁺ and water excretion

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Aldosterone directly retains water without sodium
- ✓ Primarily increases Na⁺ reabsorption (ENaC); water follows osmotically if the duct is water-permeable
- ✗ Aldosterone causes potassium retention
- ✓ Increases K⁺ secretion, favouring potassium loss
- ✗ ANP promotes water reabsorption like ADH
- ✓ ANP promotes Na⁺ and water excretion; ADH promotes water reabsorption
- ✗ ANP constricts afferent arterioles, reducing GFR
- ✓ ANP dilates afferent arterioles, tending to increase GFR

Renin-Angiotensin-Aldosterone System (RAAS)

Main active hormone	Angiotensin II
Main sodium effect	Promotes sodium retention, especially by increasing proximal tubular sodium and water reabsorption and by stimulating aldosterone.
ACE role	Converts angiotensin I to angiotensin II, mainly in pulmonary capillaries.
Vascular action	Arteriolar vasoconstriction increases blood pressure.
Hypothalamic action	Stimulates thirst and ADH release.
Adrenal cortical action	Stimulates aldosterone release.
Negative feedback	Restored blood pressure suppresses renin release.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Angiotensin I is the main active effector of RAAS
- ✓ Angiotensin II is the main biologically active effector
- ✗ ACE converts angiotensin I to II mainly in the kidney
- ✓ Mainly in pulmonary capillaries
- ✗ The main role of RAAS is vasoconstriction alone
- ✓ Its key renal purpose is sodium and water conservation
- ✗ Angiotensin II directly suppresses its own renin release
- ✓ Angiotensin II promotes aldosterone; restored blood pressure suppresses renin release

Potassium Balance

Normal Values

Intracellular K⁺	~140 mmol/L
Extracellular K⁺	3.5-5.0 mmol/L
Main mechanism maintaining gradient	Na-K ATPase
Pump direction	K ⁺ into cells; Na ⁺ out of cells
Core principle	A steep K ⁺ gradient is essential for membrane potential and cell excitability.

Effects of Disordered Potassium Balance

Hypokalaemia	Weakness, cramps, ileus; flattened T waves, U waves, prolonged QT/QU, ST depression; arrhythmia risk with digoxin.
Hyperkalaemia	Weakness, paralysis, cardiac arrest; peaked T waves progressing to broad QRS, sine wave, VF or asystole.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Tall peaked T waves indicate hypokalaemia
- ✓ U waves suggest hypokalaemia; tall peaked T waves suggest hyperkalaemia
- ✗ Muscle weakness and arrhythmia occur only in hyperkalaemia
- ✓ Both hypo- and hyperkalaemia cause them; the ECG pattern distinguishes
- ✗ QRS widening in hyperkalaemia is a minor, benign change
- ✓ QRS widening and sine-wave morphology indicate severe conduction disturbance

Renal Handling of Potassium

Aldosterone	Promotes potassium secretion in the collecting duct.
Acidosis	H ⁺ /K ⁺ exchange favours potassium leaving cells, causing a tendency to hyperkalaemia.
Alkalosis	Potassium shifts into cells, causing a tendency to hypokalaemia.
Sodium excretion/delivery	More distal sodium delivery increases potassium secretion.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Aldosterone causes sodium retention without affecting potassium
- ✓ Aldosterone also promotes potassium secretion and loss
- ✗ Acidosis tends to cause hypokalaemia
- ✓ Acidosis tends towards hyperkalaemia; alkalosis towards hypokalaemia

Calcium Balance

Normal Values

Normal total calcium	2.2–2.6 mmol/L
Albumin correction	Add 0.02 mmol/L for each 1 g/L albumin below 40 g/L
Main protein-bound fraction	Bound mainly to albumin
Physiologically active fraction	Ionised calcium
Common interpretation point	Low albumin may make total calcium appear falsely low

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Total calcium always reflects active ionised calcium
- ✓ Ionised calcium is the active fraction; total depends on albumin binding
- ✗ Calcium needs no correction when albumin is low
- ✓ Correct: add 0.02 mmol/L per 1 g/L albumin below 40 g/L
- ✗ Low albumin decreases the corrected calcium value
- ✓ Low albumin increases the corrected value

Sources and Handling of Calcium

- Calcium-rich foods include dairy products, leafy green vegetables, fortified foods and bony fish.
- Around 65% of filtered calcium is reabsorbed in the proximal tubule, mainly passively and paracellularly.
- Around 25% is reabsorbed in the loop of Henle.
- Around 8% is reabsorbed in the distal tubule, where handling is active and PTH-regulated.
- PTH increases distal tubular Ca^{2+} reabsorption and decreases phosphate reabsorption, causing phosphaturia.

Acid-Base Balance

Metabolic Disturbance

Disturbance	Primary change	Compensatory response	Main system compensating
Metabolic acidosis	HCO_3^- decreases	PaCO_2 decreases	Respiratory system
Metabolic alkalosis	HCO_3^- increases	PaCO_2 increases	Respiratory system
Respiratory acidosis	PaCO_2 increases	HCO_3^- increases	Kidneys
Respiratory alkalosis	PaCO_2 decreases	HCO_3^- decreases	Kidneys

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Kussmaul breathing indicates a primary respiratory alkalosis
- ✓ It is compensatory hyperventilation for metabolic acidosis
- ✗ Physiological compensation fully normalises pH
- ✓ Compensation moves pH towards normal but does not reverse the disturbance
- ✗ The lungs compensate for respiratory acid-base disorders
- ✓ Kidneys compensate by changing bicarbonate and hydrogen ion handling
- ✗ Raised PaCO₂ and HCO₃⁻ always indicate respiratory acidosis
- ✓ Could be metabolic alkalosis; pH (acidaemia vs alkalaemia) distinguishes them

Normal Values

Normal arterial pH	7.35-7.45
Why pH control matters	Maintains protein function and cell physiology
Buffer system	CO ₂ /HCO ₃ ⁻ system links lungs and kidneys
Henderson-Hasselbalch principle	pH follows the HCO ₃ ⁻ : dissolved CO ₂ ratio
Anion gap formula	$[\text{Na}^+] - ([\text{Cl}^-] + [\text{HCO}_3^-])$
Normal anion gap	8-12 mmol/L
Raised gap causes	Methanol, uraemia, DKA, propylene glycol, isoniazid, lactic acidosis, ethylene glycol, salicylates

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ pH is a linear measure of hydrogen ion concentration
- ✓ Logarithmic: small pH changes represent large hydrogen ion changes
- ✗ The CO₂ solubility factor of 0.03 is used with PaCO₂ in kPa
- ✓ Use 0.23 with kPa; about 0.03 with mmHg
- ✗ Anion gap = $[\text{Na}^+] - [\text{Cl}^-]$
- ✓ $[\text{Na}^+] - ([\text{Cl}^-] + [\text{HCO}_3^-])$; normal 8-12 mmol/L
- ✗ All metabolic acidoses have a raised anion gap
- ✓ Not all; the anion gap helps separate different mechanisms

Renal Regulation of Acid-Base Balance

Filtered bicarbonate	Mainly reclaimed in the proximal tubule via carbonic anhydrase-dependent conversion between HCO ₃ ⁻ , CO ₂ and water.
Titrateable acid	H ⁺ combines with HPO ₄ ²⁻ to form H ₂ PO ₄ ⁻ for urinary excretion.
Ammonium	Glutamine metabolism generates NH ₃ ; NH ₃ + H ⁺ forms NH ₄ ⁺ , which is excreted.
Net acid excretion	Approximately 50-100 mEq/day in health.
Acidosis	Increases renal H ⁺ secretion.
Aldosterone	Increases H ⁺ secretion alongside Na ⁺ retention.
Hypercapnia	Increases H ⁺ secretion as part of renal compensation for respiratory acidosis.
Hypokalaemia	Increases H ⁺ secretion and can maintain metabolic alkalosis.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Bicarbonate is directly reabsorbed intact from the tubular lumen
- ✓ Reclaimed indirectly via CO₂ in the proximal tubule; carbonic anhydrase is central
- × Net acid excretion occurs mainly through bicarbonate reclamation
- ✓ Net acid excretion is mainly via titratable acid and ammonium
- × Urinary ammonium derives mainly from urea breakdown
- ✓ Generated from glutamine metabolism; especially important in sustained acidosis
- × Hypokalaemia reduces renal H⁺ secretion
- ✓ Hypokalaemia increases renal H⁺ secretion and can maintain metabolic alkalosis

PHYSIOLOGY · TOPIC 6 OF 6

Endocrine Physiology

Pituitary Function

Effects of Disordered Pituitary Function

ACTH deficiency	Reduced adrenal cortisol stimulation; risk of adrenal insufficiency physiology.
TSH deficiency	Reduced thyroid hormone stimulation; secondary hypothyroid physiology.
DI	Absent or ineffective ADH: dilute polyuria, polydipsia, hypernatraemia.
Central DI	Too little ADH secretion from hypothalamic-pituitary dysfunction.
Nephrogenic DI	Kidney does not respond normally to ADH.
SIADH	Excess ADH effect: water retention, hyponatraemia, concentrated urine.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Diabetes insipidus is primarily a glucose disorder
- ✓ DI is a water-balance disorder from absent or ineffective ADH
- × All diabetes insipidus is pituitary in origin
- ✓ Nephrogenic DI has adequate or increased ADH but impaired renal response
- × SIADH produces dilute urine because plasma osmolality is low
- ✓ SIADH produces concentrated urine despite low plasma osmolality
- × Diabetes insipidus causes hyponatraemia
- ✓ DI tends towards hypernatraemia; SIADH causes dilutional hyponatraemia

Functional Anatomy of the Pituitary

Location	Sella turcica of the sphenoid bone; visible as a skull-base structure on radiographs and CT
Anterior pituitary	Adenohypophysis; glandular; produces trophic hormones such as ACTH and TSH
Posterior pituitary	Neurohypophysis; neural extension; stores and releases ADH
Anterior pituitary control	Hypothalamic releasing/inhibiting hormones via the hypothalamopituitary portal system
CRH	Stimulates ACTH release
TRH	Stimulates TSH and prolactin release
Dopamine	Inhibits prolactin release

ADH	Promotes water reabsorption by the kidney
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ ADH is synthesised in the posterior pituitary
- ✓ Synthesised in the hypothalamus; stored and released from the posterior pituitary
- ✗ The posterior pituitary is glandular tissue like the anterior pituitary
- ✓ It is a neural extension of the hypothalamus (neurohypophysis)
- ✗ Dopamine stimulates prolactin release
- ✓ Dopamine inhibits prolactin release; TRH stimulates TSH and prolactin
- ✗ The pituitary sits in the sella turcica of the ethmoid bone
- ✓ Sella turcica of the sphenoid bone

Thyroid Physiology

Effects of Disordered Thyroid Function

Feature	Hypothyroidism	Hyperthyroidism
Hormone state	Insufficient T3/T4 effect	Excess T3/T4 effect
Overall physiology	Hypometabolic, low-output pattern	Hypermetabolic, high-output pattern
Weight	Weight gain	Weight loss despite appetite
Heart rate/rhythm	Bradycardia	Tachycardia; atrial fibrillation risk
Temperature tolerance	Cold intolerance	Heat intolerance and sweating
Bowel habit	Constipation	Diarrhoea
Skin/hair	Dry skin, hair loss, myxoedema if severe	Sweating; pretibial myxoedema in Graves disease

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Pretibial myxoedema is a feature of severe hypothyroidism
- ✓ Pretibial myxoedema is classically associated with Graves disease
- ✗ Bradycardia is the key cardiac effect of hyperthyroidism
- ✓ Tachycardia with atrial fibrillation risk
- ✗ Hypothyroidism is always due to thyroid gland failure
- ✓ Secondary pituitary or hypothalamic failure can also cause insufficient thyroid hormone

Functional Anatomy

The thyroid is a bilobed anterior neck gland whose isthmus crosses the second and third tracheal rings. Its main function is production of T4 and T3.

Physiological Effects of Thyroid Hormones

Main cardiovascular effect	Increased heart rate and contractility, producing raised cardiac output
Main calorogenic effect	Increased basal metabolic rate and heat production
Core physiological pattern	Thyroid hormones increase the pace of tissue metabolism
Excess hormone	High-output, hypermetabolic pattern
Deficient hormone	Low-output, hypometabolic pattern

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Thyroid hormone cardiac and calorogenic effects arise from separate mechanisms
- ✓ Both reflect increased tissue metabolic activity

Transport of Thyroid Hormones

Thyroid hormone transport is dominated by protein binding. T4 circulates mostly attached to TBG, albumin and prealbumin, leaving only a small free fraction that is biologically active. Free T4 is therefore central to interpretation, while TSH reflects pituitary feedback. T4 functions largely as a circulating prohormone and is converted in tissues to the more potent T3.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Total T4 represents the biologically active hormone
- ✓ The small free fraction is biologically active
- ✗ Most circulating T4 is free in plasma
- ✓ More than 99% of T4 is protein-bound (TBG, albumin, prealbumin)
- ✗ T4 is more potent than T3
- ✓ T3 is more potent; T4 is the major circulating prohormone converted in tissues
- ✗ Free T4 is measured in mIU/L
- ✓ TSH is in mIU/L; free T4 is in pmol/L

Adrenal Function

Adrenal Cortical Function

Outer cortical zone	Zona glomerulosa: aldosterone.
Middle cortical zone	Zona fasciculata: cortisol.
Inner cortical zone	Zona reticularis: DHEA and adrenal androgens.
Main control of cortisol	CRH → ACTH → cortisol from adrenal cortex.
Main control of aldosterone	Renin-angiotensin system, especially angiotensin II.
Stress response	Stress → CRH → ACTH → cortisol; supports metabolic adaptation.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The zona reticularis is the outermost adrenal cortical zone
- ✓ Glomerulosa outer, fasciculata middle, reticularis inner
- ✗ ACTH is the main regulator of aldosterone
- ✓ Renin-angiotensin system (angiotensin II) is the dominant regulator
- ✗ Cortisol is produced by the zona glomerulosa
- ✓ Zona fasciculata, stimulated by ACTH
- ✗ The adrenal cortex secretes catecholamines
- ✓ Catecholamines come from the adrenal medulla; the cortex secretes steroids

Adrenal Medullary Function

Main role	Endocrine component of the sympathetic nervous system
Main cell type	Chromaffin cells

Stimulus	Sympathetic stimulation
Route of release	Directly into bloodstream
Main secretion	Adrenaline about 80%; noradrenaline about 20%
Breakdown enzymes	MAO and COMT
Metabolites	Metanephrines, excreted in urine
Clinical link	Urinary/plasma metanephrines help investigate phaeochromocytoma

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Noradrenaline is the main adrenal medullary secretion
- ✓ Adrenaline ~80%; noradrenaline ~20%
- ✗ The adrenal medulla secretes steroid hormones
- ✓ Medulla secretes catecholamines; cortex secretes steroids
- ✗ Metanephrines are precursors of catecholamine synthesis
- ✓ Metabolites of catecholamine breakdown (MAO, COMT); measured in suspected phaeochromocytoma

Clinical Effects of Disordered Glucocorticoid Secretion

Cushing's syndrome	Excess cortisol: central obesity, diabetes, hypertension, striae, bruising, proximal myopathy, osteoporosis and immunosuppression.
Addison's disease	Cortisol ± aldosterone deficiency: fatigue, weight loss, hypotension, hyponatraemia, hyperkalaemia, hyperpigmentation and hypoglycaemia.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Cushing's syndrome is indistinguishable from simple obesity
- ✓ Proximal myopathy, striae, bruising, diabetes and hypertension indicate glucocorticoid excess
- ✗ Hyperpigmentation in Addison's is a direct effect of low cortisol
- ✓ Due to raised ACTH in primary adrenal insufficiency
- ✗ Hyponatraemia and hyperkalaemia in Addison's reflect cortisol deficiency alone
- ✓ They reflect aldosterone deficiency as well as cortisol deficiency

Clinical Effects of Disordered Medullary Function

Key disorder	Phaeochromocytoma
Physiological basis	Catecholamine-secreting tumour of adrenal medulla or extra-adrenal chromaffin tissue.
Main cardiovascular effect	Paroxysmal or sustained hypertension.
Autonomic symptom cluster	Headache, palpitations, sweating, pallor/flushing and anxiety.
Metabolic effect	Hyperglycaemia due to catecholamine-driven glucose mobilisation and reduced insulin secretion.
Rule of 10%	Traditional memory aid: 10% bilateral, extra-adrenal, malignant and familial.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Extra-adrenal catecholamine-secreting tumours are adrenal adenomas
- ✓ They are paragangliomas
- ✗ Pheochromocytoma has purely cardiovascular effects
- ✓ Also causes hyperglycaemia via glucose mobilisation and reduced insulin secretion
- ✗ Pheochromocytoma symptoms are always constant
- ✓ Catecholamine release may be episodic, producing paroxysmal attacks

Effects of Adrenaline

System	Effect of adrenaline	Exam link
Metabolic	Glycogenolysis, lipolysis and inhibition of insulin secretion	Raises blood glucose and free fatty acids.
Heart	Increased rate and contractility via β_1 receptors	Increases cardiac output.
Vessels	β_2 vasodilation in skeletal muscle; α_1 vasoconstriction in skin and viscera	Redistributes blood flow during stress.
Lungs	Bronchodilation via β_2 receptors	Reduces airway resistance.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Adrenaline causes uniform vasoconstriction in all vascular beds
- ✓ β_2 dilates skeletal muscle vessels; α_1 constricts skin and visceral vessels
- ✗ Adrenaline's cardiac effects are mediated by β_2 receptors
- ✓ β_1 is mainly cardiac; β_2 mediates bronchodilation and muscle vasodilation
- ✗ Adrenaline stimulates insulin secretion
- ✓ Adrenaline inhibits insulin secretion while raising blood glucose

Effects of Glucocorticoids

Anti-inflammatory	Suppresses inflammatory responses.
Immunosuppressive	Reduces immune activation and host inflammatory defence.
Gluconeogenesis	Raises blood glucose by increasing hepatic glucose production.
Lipolysis	Mobilises fat stores and may contribute to fat redistribution.
Protein catabolism	Breaks down muscle protein; supports gluconeogenesis but can cause wasting.
High-dose mineralocorticoid activity	Sodium retention and potassium loss.
Bone resorption	Favours loss of bone mass over time.
Mood and cognition	Can alter mood, sleep, concentration and behaviour.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Glucocorticoids lower blood glucose
- ✓ They raise blood glucose by promoting hepatic gluconeogenesis
- ✗ Glucocorticoids are anabolic to muscle protein
- ✓ Protein catabolism; chronic excess causes muscle wasting
- ✗ Only aldosterone causes sodium retention and potassium loss
- ✓ High-dose glucocorticoids also have mineralocorticoid activity

Functional Anatomy of the Adrenal Glands

Position	Superior poles of kidneys
Anatomical compartment	Retroperitoneal
Main subdivision	Outer cortex and inner medulla
Cortex	Mesoderm-derived; three zones
Medulla	Neural-crest-derived; chromaffin cells

Endocrine Pancreas

Diabetes Mellitus

Type 1 DM	Autoimmune beta-cell destruction causing absolute insulin deficiency
Type 2 DM	Insulin resistance with relative insulin deficiency
Untreated hyperglycaemia	Glycosuria and osmotic diuresis
Classic symptoms	Polyuria, polydipsia and polyphagia
DKA	Insulin deficiency leading to unopposed glucagon and ketogenesis
HHS/HONK	Severe hyperglycaemia and hyperosmolality, usually in type 2 DM

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Type 2 diabetes is caused by absolute insulin absence
- ✓ Insulin resistance with relative insulin deficiency
- × DKA is defined simply by high blood glucose
- ✓ Driven by insulin deficiency with unopposed glucagon and ketogenesis
- × HONK and HHS are different conditions
- ✓ Same hyperosmolar presentation; HHS is the modern term, classically in type 2 diabetes

Functional Anatomy of Endocrine Pancreas

Main endocrine structure	Islets of Langerhans
Beta-cell product	Insulin
Beta-cell importance	Majority of islet cells; lowers blood glucose
Alpha-cell product	Glucagon
Alpha-cell importance	Raises blood glucose as a counter-regulatory hormone

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Insulin and glucagon are exocrine pancreatic secretions
- ✓ Endocrine (islets); digestive enzyme secretion is exocrine
- × Alpha cells produce insulin and beta cells produce glucagon
- ✓ Beta cells produce insulin; alpha cells produce glucagon

Glucagon Physiology

Main source	Pancreatic alpha cells
Primary stimulus	Hypoglycaemia

Other stimuli	Amino acids and sympathetic stimulation
Major target organ	Liver
Main glucose effects	Glycogenolysis and gluconeogenesis
Fat/ketone effects	Lipolysis and ketogenesis
Net effect	Raises or maintains blood glucose

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Glucagon stores fuel like insulin
- ✓ Glucagon mobilises fuel; insulin stores fuel
- ✗ Glucagon promotes glycogen synthesis
- ✓ Glucagon promotes glycogenolysis
- ✗ Ketogenesis is promoted by high insulin activity
- ✓ Promoted by high glucagon and low insulin activity

Insulin Physiology

Primary stimulus	Rising blood glucose
Additional stimuli	Amino acids, fatty acids, GLP-1 and parasympathetic stimulation
Precursor	Proinsulin, cleaved to insulin and C-peptide
Clinical marker	C-peptide indicates endogenous insulin production
Receptor type	Tyrosine kinase receptor
Key signalling pathway	PI3K/Akt pathway leading to GLUT4 insertion
Overall effect	Lowers blood glucose and promotes anabolic storage

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Insulin raises blood glucose
- ✓ Insulin lowers blood glucose; glucagon raises it
- ✗ C-peptide is present in injected insulin preparations
- ✓ C-peptide is released only with endogenous insulin
- ✗ GLUT2 is the insulin-responsive transporter in muscle and fat
- ✓ GLUT4 is insulin-responsive in skeletal muscle and adipose tissue
- ✗ Insulin promotes lipolysis
- ✓ Insulin inhibits lipolysis

Normal Blood Glucose

Normal fasting glucose	3.9-6.1 mmol/L
Conventional unit equivalent	70-110 mg/dL

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Normal fasting glucose is defined using post-prandial values
- ✓ Normal fasting glucose is 3.9–6.1 mmol/L
- ✗ Normal fasting glucose is 3.9–6.1 mg/dL
- ✓ 3.9–6.1 mmol/L equals 70–110 mg/dL
- ✗ Normal fasting glucose upper limit is about 10 mmol/L
- ✓ ~10 mmol/L is the renal glucose threshold; normal fasting is 3.9–6.1 mmol/L

Calcium and Bone Physiology

Effects of Disordered Calcium Physiology

Osteoporosis	Low bone mass; normal mineralisation; micro-architectural deterioration.
Osteoporosis risk factors	Post-menopausal oestrogen deficiency, inactivity, low calcium/vitamin D intake, steroids, smoking.
Osteomalacia / rickets	Reduced mineralisation due to vitamin D or calcium deficiency.
Clinical picture of osteomalacia	Soft bones, bone pain, Looser's zones on X-ray.
Trauma relevance	Low-impact fragility fractures, especially vertebral crush, neck of femur, distal radius and proximal humerus.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Osteoporosis is defined by poor bone mineralisation
- ✓ Reduced bone mass with normal mineralisation
- ✗ Osteomalacia is reduced bone mass with normal mineralisation
- ✓ Osteomalacia is a mineralisation defect causing soft, painful bones
- ✗ Fragility fractures occur only at the hip
- ✓ Vertebral crush, distal radius and proximal humerus are also typical

Factors Affecting Calcium Handling

What releases PTH?	Hypocalcaemia
What does PTH do in the kidney?	Increases distal tubular Ca^{2+} reabsorption, increases phosphate excretion and activates vitamin D
What does PTH do in bone?	Promotes osteoclast activity and bone resorption, releasing Ca^{2+} and phosphate
What releases calcitonin?	Hypercalcaemia
What is calcitonin's net effect?	Lowers plasma calcium
What is calcitriol's primary action?	Increases Ca^{2+} absorption from the small intestine
How is vitamin D3 activated?	Skin cholecalciferol → liver 25-hydroxylation → kidney 1 alpha-hydroxylation

EXAM TRAPS × tempting option ✓ correct answer

- ✗ PTH is released in response to hypercalcaemia
- ✓ Released by hypocalcaemia
- ✗ PTH increases renal phosphate reabsorption

- ✓ PTH increases calcium reabsorption but decreases phosphate reabsorption
- ✗ PTH directly increases small intestinal calcium absorption
- ✓ Indirect: via renal activation of vitamin D
- ✗ Calcitonin is released by hypocalcaemia
- ✓ Released by hypercalcaemia; lowers plasma calcium
- ✗ Calcitriol primarily acts by causing bone resorption
- ✓ Primarily increases small intestinal calcium absorption; supports mineralisation at normal levels

Functions of Calcium in Health

Muscle contraction	Required in cardiac, skeletal and smooth muscle.
Neurotransmission	Ca ²⁺ entry at nerve terminals triggers vesicle exocytosis.
Coagulation	Needed by multiple clotting factors.
Enzyme activation	Ca ²⁺ can activate intracellular proteins and enzymes.
Second messenger	Acts via calmodulin and other calcium-sensitive pathways.
Mineralisation	Forms hydroxyapatite in bone and teeth.
Blood transport	~50% ionised, ~45% albumin-bound, ~5% complexed.

⚠ EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ Total calcium is the physiologically active fraction
- ✓ Ionised calcium (~50%) is the active fraction
- ✗ Calcium is required only for muscle contraction
- ✓ Also required for neurotransmitter release (vesicle exocytosis)

NOW TEST IT

Reading Physiology is not the same as answering it under time pressure.

Physiology MCQs test direction of change, not definitions. Practise with timed questions and see which mechanisms you still reverse under pressure.

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CHAPTER 3

Pharmacology

10 curriculum topics · 107 subtopics · 377 exam traps

Gastrointestinal Pharmacology · Cardiovascular System · Respiratory System · Central Nervous System · Infections · Endocrine System · Fluids and Electrolytes · Musculoskeletal System · Immunological Products and Vaccines · Anaesthesia

PHARMACOLOGY · TOPIC 1 OF 10

Gastrointestinal Pharmacology

Acute Diarrhoea

Management Principles

Main treatment aim	Fluid and electrolyte replacement
Antimotility drugs	Limited role; avoid in children, bloody diarrhoea and suspected invasive infection
Antispasmodics	No emergency role; not appropriate in children

 **EXAM TRAPS** × tempting option ✓ correct answer

- × Loperamide is routine first-line therapy for acute diarrhoea
- ✓ Priority is fluid and electrolyte replacement, not slowing transit
- × Antimotility drugs are appropriate in bloody diarrhoea
- ✓ Avoid in bloody diarrhoea, suspected invasive infection and children
- × Antispasmodics are useful in acute diarrhoea with cramps
- ✓ Antispasmodics have no emergency role in acute diarrhoea

Antispasmodics

Antimuscarinics

Core action	Muscarinic receptor antagonism reduces parasympathetic smooth muscle activity.
Main cautions	Urinary retention, angle-closure glaucoma, prostate hypertrophy, paralytic ileus, myasthenia gravis.
Common adverse effects	Dry mouth, blurred vision, urinary retention, constipation, tachycardia, confusion.
Hyoscine butylbromide	Poor oral absorption; limited clinical utility when given by mouth.

 **EXAM TRAPS** × tempting option ✓ correct answer

- × Antimuscarinic adverse effects are limited to the gut
- ✓ Important risks involve bladder, eye, heart and CNS
- × Antimuscarinics do not cause confusion in elderly patients
- ✓ Anticholinergic confusion is a risk, especially with multiple antimuscarinic drugs

Chronic Bowel Disorders (Inflammatory Bowel Disease)

Acute Exacerbations of IBD

Admission	Consider for moderate to severe exacerbations
Supportive care	Nutritional support and VTE prophylaxis
Distal disease	Local steroids and local aminosalicylates
Mild to moderate disease	Oral aminosalicylates
Moderate to severe disease	Oral steroids to induce remission

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × VTE prophylaxis is unnecessary in acute IBD exacerbations
- ✓ Active IBD is prothrombotic; give VTE prophylaxis, especially if admitted
- × Distal IBD should always be treated with oral therapy
- ✓ Distal disease may be treated with local rectal steroids and aminosalicylates
- × Oral steroids are used as IBD maintenance therapy
- ✓ Oral steroids induce remission in moderate to severe exacerbations

Dyspepsia and Gastro-Oesophageal Reflux Disease (GORD)

Antacids

Main action	Neutralisation of gastric acid.
Aluminium hydroxide	Antacid; tends to constipate.
Magnesium carbonate	Antacid; tends to be laxative.
Key interaction principle	Reduced absorption of important oral drugs.
Affected examples	Tetracyclines, quinolones, iron, ketoconazole, bisphosphonates.
Practical prescribing point	Separate timing from susceptible medicines.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Aluminium hydroxide is laxative; magnesium carbonate constipates
- ✓ Aluminium hydroxide constipates; magnesium carbonate is laxative
- × Antacids suppress gastric acid secretion like PPIs
- ✓ Antacids neutralise existing acid; PPIs suppress acid secretion

Management Principles

Core management principle	Drug treatment is based on symptom severity.
Drug strategy	Use a step-up approach, escalating when symptoms require it.
Lifestyle strategy	Address weight, smoking, diet, posture and meal timing.
Nocturnal reflux measure	Elevate the bed head and avoid late meals.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Lifestyle advice is optional in GORD management
- ✓ Lifestyle change is needed for maximal symptom control
- ✗ All GORD patients receive the same drug intensity
- ✓ Treatment is symptom-severity based, using a step-up approach
- ✗ GORD lifestyle management is limited to dietary change
- ✓ Includes weight loss, smoking cessation, bed-head elevation, avoiding late meals and trigger foods

Laxatives

Laxative Principles

Core risks	Abdominal cramp, electrolyte disturbance with overuse, dependence, and danger in bowel obstruction.
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⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Constipation in ED should always be treated with a laxative
- ✓ First exclude bowel obstruction and acute abdominal pathology; laxatives have a very limited ED role
- ✗ Stimulant laxatives are appropriate in bowel obstruction
- ✓ Stimulant laxatives are contraindicated in bowel obstruction

Ulcer-Healing Drugs

Management Overview

Core aim	Reduce acid exposure and allow mucosal healing
Underlying causes	Consider H. pylori infection and NSAID exposure
Key drug class	Proton pump inhibitors for effective acid suppression
Safety principle	Persistent or alarm symptoms need investigation, not repeated empirical treatment alone

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Peptic ulcer disease is simply a problem of acid excess
- ✓ Consider the underlying cause, particularly H. pylori infection and NSAID use
- ✗ Acid suppression has no effect on detecting gastric carcinoma
- ✓ Acid suppression may mask symptoms of gastric carcinoma

NSAID-Associated Ulcers

Cause	NSAID inhibition of COX-1
Mediating change	Reduced prostaglandin synthesis
Mucosal effect	Reduced gastric and duodenal mucosal protection
Outcome	Ulceration, with possible bleeding
Treatment of choice	Proton pump inhibitor
Prevention	Consider PPI co-prescription in at-risk NSAID users

EXAM TRAPS × tempting option ✓ correct answer

- × NSAID ulcers are caused primarily by excess gastric acid
- ✓ Loss of prostaglandin-mediated mucosal protection via COX-1 inhibition initiates NSAID ulceration

Proton Pump Inhibitors (PPIs)

Drug	Omeprazole
Mechanism	Irreversible inhibition of parietal cell H-K-ATPase
Activation	Acid-activated prodrug in the secretory canaliculus
Timing	Take before meals, as PPIs best inhibit actively secreting pumps
NSAID ulcers	Treatment and prevention of NSAID-induced peptic ulceration
Cautions	Masking gastric carcinoma; increased C. difficile and Salmonella risk
Interactions	Clopidogrel, warfarin
Adverse effects	GI disturbance, headache, hypomagnesaemia, fracture risk, C. difficile
Dose	Oral 20-40 mg once daily; IV 40 mg once or twice daily in acute upper GI bleeding

EXAM TRAPS × tempting option ✓ correct answer

- × PPIs act immediately, like antacids
- ✓ Maximal effect develops over time, as PPIs irreversibly inhibit actively secreting pumps
- × Omeprazole has no significant interaction with clopidogrel
- ✓ Omeprazole can reduce clopidogrel's antiplatelet effect
- × Persistent or alarm-feature dyspepsia can be managed with a PPI alone
- ✓ Investigate for gastric carcinoma; PPIs can mask its symptoms
- × Long-term PPI therapy carries no significant risks
- ✓ Long-term risks include hypomagnesaemia, fracture risk and C. difficile infection

PHARMACOLOGY · TOPIC 2 OF 10

Cardiovascular System

Anti-Arrhythmic Drugs

Adenosine

Mechanism	A1 receptor activation at the AV node causing transient conduction block.
Half-life	Approximately 10 seconds.
Main therapeutic use	First-line termination of SVT including AVNRT and AVRT.
Diagnostic use	Slows ventricular response to reveal flutter or AF.
Dose	6 mg rapid IV bolus, then 12 mg, then 18 mg if needed.
Administration	Rapid bolus through antecubital or central vein with immediate saline flush.
Typical adverse effects	Flushing, chest tightness, dyspnoea, nausea, transient heart block, seconds of asystole.
Key danger	WPW with pre-excited AF: avoid because of VF risk.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Adenosine may be given as a slow IV injection
- ✓ Give as a rapid IV bolus followed immediately by a saline flush (half-life about 10 seconds)
- ✗ Adenosine terminates all narrow-complex tachycardias
- ✓ Terminates AV node-dependent SVT (AVNRT/AVRT); often only reveals atrial flutter or AF
- ✗ Standard 6 mg adenosine is used with dipyridamole or after heart transplant
- ✓ Start with 3 mg in patients on dipyridamole or heart transplant recipients
- ✗ Adenosine is safe in WPW with pre-excited AF
- ✓ Avoid: it can precipitate ventricular fibrillation
- ✗ Asthma is not a contraindication to adenosine
- ✓ Significant asthma is a contraindication because of bronchospasm risk

Amiodarone

Main class effect	Class III: K ⁺ channel blockade
ECG effect	QT prolongation
ALS use	VF/pulseless VT after the third shock
ALS dose	300 mg IV/IO, then 150 mg if persistent/recurrent after further shocks
Stable tachyarrhythmia dose	300 mg IV over 20-60 min, then 900 mg over 24 h
Acute adverse effects	Phlebitis, hypotension, bradycardia, QT prolongation, pulmonary toxicity
Chronic adverse effects	Thyroid dysfunction, pulmonary fibrosis, hepatotoxicity, corneal microdeposits, photosensitivity, neuropathy, blue-grey skin
Major interactions	Warfarin, digoxin, QT-prolonging drugs

⚠ EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ Stable tachyarrhythmia uses the 300 mg bolus cardiac arrest regimen
- ✓ Stable: 300 mg IV over 20-60 min, then 900 mg over 24 h; arrest: 300 mg bolus, then 150 mg
- ✗ Amiodarone is a pure Class III anti-arrhythmic
- ✓ Mainly Class III, but Class I, II and IV effects contribute to its broad use
- ✗ QT prolongation with amiodarone is an unexpected idiosyncratic effect
- ✓ QT prolongation is expected; concurrent QT-prolonging drugs and electrolyte disturbance increase risk
- ✗ Amiodarone has no important interactions with digoxin or warfarin
- ✓ Amiodarone interacts importantly with both digoxin and warfarin

Flecainide

Class	Class IC anti-arrhythmic
Main mechanism	Blocks fast sodium channels and slows conduction velocity
Additional action	Also blocks potassium channels
Key indications	AF <48 hours in stable patients with structurally normal hearts; WPW-related tachyarrhythmias
Major contraindication	Structural heart disease, including previous MI, heart failure and LVH
Most important adverse effect	Pro-arrhythmia, including VT/VF

EXAM TRAPS × tempting option ✓ correct answer

- × Flecainide can be used for AF regardless of structural heart disease
- ✓ Use only with structurally normal hearts; structural heart disease makes it unsafe
- × Previous MI or LVH does not affect flecainide safety
- ✓ Previous MI, heart failure and significant LVH contraindicate flecainide (pro-arrhythmia, VT/VF)
- × Haemodynamically unstable tachyarrhythmia should be treated with flecainide
- ✓ Unstable patients need urgent cardioversion and resuscitation, not flecainide

Lidocaine

What class is lidocaine?	Class IB anti-arrhythmic.
What channel does it block?	Fast voltage-gated sodium channels.
What tissue does it preferentially affect?	Ischaemic or depolarised ventricular myocardium.
What happens to action potential duration?	It is shortened.
When is it used in ALS?	As an alternative to amiodarone in VF/pulseless VT when amiodarone is unavailable or local guidance selects lidocaine.

EXAM TRAPS × tempting option ✓ correct answer

- × Lidocaine is first-line for VF/pulseless VT in ALS
- ✓ Amiodarone is usually first-line; lidocaine is the alternative
- × Class IB drugs such as lidocaine prolong the action potential
- ✓ Class IB drugs shorten the action potential; amiodarone prolongs it

Beta-Adrenoceptor Blockers

Class Overview

Core mechanism	Competitive antagonism at beta-adrenoceptors.
Beta-1 effects	Reduced heart rate, contractility, AV conduction, and renin release.
Beta-2 effects	Bronchoconstriction, peripheral vasoconstriction, and impaired hypoglycaemia response.
Selectivity	Cardioselective = mainly beta-1; non-selective = beta-1 plus beta-2.
Major uses	Angina, hypertension, post-MI, chronic stable heart failure, AF rate control, thyrotoxicosis.
Major hazards	Bradycardia, heart block, bronchospasm, worsening decompensated heart failure, cold extremities, masked hypoglycaemia.

EXAM TRAPS × tempting option ✓ correct answer

- × Cardioselective beta-blockers are completely safe in asthma
- ✓ Beta-1 selectivity is relative; bronchospasm can still occur
- × Beta-blockers are contraindicated in all heart failure
- ✓ Used at low stable doses in chronic stable heart failure; may worsen decompensated heart failure
- × Beta-blockers mask hypoglycaemia by preventing glucose recovery entirely
- ✓ Masking refers mainly to loss of adrenergic warning symptoms: tremor, palpitations, tachycardia
- × Beta-blockers are safe in second- or third-degree AV block
- ✓ Contraindicated, because beta-blockers slow AV nodal conduction

Esmolol

Drug type	Beta-1 selective beta-blocker
Route	IV only
Half-life	About 9 minutes
Main effects	Reduced heart rate, reduced AV conduction, reduced contractility
Core uses	Acute SVT rate control, perioperative hypertension, aortic dissection
Main advantage	Rapid titration and quick reversibility

EXAM TRAPS × tempting option ✓ correct answer

- × Esmolol is an oral beta-blocker for chronic use
- ✓ IV only; key role is short-term titration (half-life about 9 minutes)
- × Esmolol is completely safe in asthma or severe COPD because it is cardioselective
- ✓ Beta-1 selectivity is relative; caution remains in asthma and severe COPD
- × In aortic dissection, esmolol's benefit is solely blood pressure reduction
- ✓ Reducing heart rate and contractility is central because it reduces aortic shear stress
- × Esmolol's short half-life means monitoring is unnecessary
- ✓ Short half-life makes it safer to trial in unstable situations, but monitoring is still essential

Labetalol

Class	Mixed alpha and beta blocker
Receptor profile	Non-selective beta blockade plus alpha-1 blockade
Main effect	Reduces blood pressure without reflex tachycardia
Key uses	Hypertensive emergencies, pregnancy-related severe hypertension, aortic dissection
Acute route	IV bolus or IV infusion

EXAM TRAPS × tempting option ✓ correct answer

- × Labetalol is a pure beta-blocker
- ✓ Mixed: non-selective beta plus alpha-1 blockade; alpha-1 blockade is central to its BP effect
- × Labetalol's vasodilation causes reflex tachycardia
- ✓ Its beta-blockade limits reflex tachycardia
- × Beta-blocker contraindications do not apply to labetalol
- ✓ Labetalol is a beta-blocker; class contraindications (e.g. asthma, heart block) still apply

Propranolol

Class	Non-selective beta-adrenoceptor blocker
Receptors blocked	Beta-1 and beta-2
Key pharmacokinetic feature	Lipid-soluble; crosses the blood-brain barrier
CNS effects	Nightmares, sleep disturbance and fatigue
Core uses	Hypertension, anxiety symptoms, migraine prophylaxis, thyrotoxicosis, essential tremor, portal hypertension
Major contra-indication	Asthma (beta-2 blockade can provoke bronchospasm); caution in COPD

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Propranolol is a cardioselective beta-blocker
- ✓ Non-selective: blocks both beta-1 and beta-2 receptors
- × Propranolol is a sedative anxiolytic
- ✓ It controls peripheral adrenergic symptoms of anxiety
- × Propranolol does not cross the blood-brain barrier
- ✓ Lipid-soluble; CNS penetration causes nightmares, sleep disturbance and fatigue

Sotalol

Class	Non-selective beta blocker with Class III anti-arrhythmic properties
Class III mechanism	Potassium channel blockade
ECG effect	Prolongs action potential and QT interval
Uses	Ventricular arrhythmias; maintenance of sinus rhythm in AF
Major risk	Torsades de pointes
Key cautions	QT prolongation, electrolyte disturbance, renal failure

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Sotalol is simply a non-selective beta-blocker
- ✓ Also has Class III potassium channel-blocking action, prolonging QT
- × Sotalol's anti-arrhythmic action cannot itself cause arrhythmias
- ✓ QT prolongation makes it pro-arrhythmic, notably torsades de pointes
- × Hypokalaemia and bradycardia do not affect sotalol torsades risk
- ✓ Hypokalaemia, bradycardia and other QT-prolonging drugs increase torsades risk
- × Renal failure is not a caution with sotalol
- ✓ Renal failure is a caution: accumulation increases toxicity risk

Cardiac Glycosides

Digoxin-Specific Antibody

Drug class	Digoxin-specific antibody fragments
Example names	DigiFab / Digibind
Mechanism	Bind digoxin and rapidly reduce free active digoxin
Core use	Severe or life-threatening digoxin toxicity

Key indications	Life-threatening arrhythmia; potassium >5.0 mmol/L in acute overdose; severe haemodynamic compromise
Supportive step	Stop digoxin and correct relevant electrolyte abnormalities, especially hypokalaemia

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Any raised digoxin level warrants digoxin-specific antibody fragments
- ✓ Reserve for severe toxicity: life-threatening arrhythmia, K⁺ >5.0 mmol/L in acute overdose, haemodynamic compromise
- × Hyperkalaemia in acute digoxin overdose is reassuring or irrelevant
- ✓ Marks severe poisoning; K⁺ >5.0 mmol/L indicates antibody fragments; hypokalaemia predisposes to toxicity
- × Digoxin toxicity causes only one specific arrhythmia
- ✓ Almost any arrhythmia; AF with slow regular ventricular rate and bidirectional VT are classic clues

Digoxin

Class	Cardiac glycoside
Main pump target	Na-K ATPase
Inotropic mechanism	Increased intracellular sodium reduces Na-Ca exchange, increasing intracellular calcium
Rate-control mechanism	Slows AV nodal conduction via vagal effect
Key indications	AF rate control, especially with heart failure; add-on therapy in HFrEF in sinus rhythm
Therapeutic range	Narrow, typically 0.5-2.0 nanomol/L; check local guidance
Most important toxicity risk factor	Hypokalaemia
Classic visual symptom	Yellow-green haloes / xanthopsia
Severe toxicity antidote	Digoxin-specific antibody fragments

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Digoxin toxicity causes only bradycardia
- ✓ Almost any arrhythmia, including ventricular ectopics and bidirectional VT
- × Hyperkalaemia is the key precipitant of digoxin toxicity
- ✓ Hypokalaemia is the key precipitant, especially with loop or thiazide diuretics
- × A previously stable digoxin dose remains safe despite renal impairment
- ✓ Reduced renal clearance can make a previously stable dose toxic
- × Hypokalaemia in acute digoxin overdose marks severe poisoning
- ✓ Hyperkalaemia marks severe acute overdose; hypokalaemia predisposes to chronic toxicity

Diuretics

Broad Categorisation of Diuretics

Diuretic category	Exam-defining mechanism	Potassium effect
Loop	Blocks NKCC2 in thick ascending limb	Hypokalaemia risk
Thiazide	Blocks NCC in distal convoluted tubule	Hypokalaemia risk
Potassium-sparing	Aldosterone antagonism or ENaC blockade	Potassium retention

Diuretic category	Exam-defining mechanism	Potassium effect
Osmotic	Increases tubular osmolality	Variable; defined by osmotic water retention in tubule

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Only loop diuretics cause hypokalaemia
- ✓ Thiazides also cause hypokalaemia
- ✗ Diuretic hypokalaemia results from direct potassium-channel opening
- ✓ Shared mechanism is increased distal sodium delivery
- ✗ Potassium-sparing diuretics produce a stronger diuresis
- ✓ They are defined by potassium retention, not diuretic strength
- ✗ Hypokalaemia in a patient on digoxin is a minor biochemical finding
- ✓ Hypokalaemia increases digoxin toxicity risk

Loop Diuretics

Class site of action	Thick ascending limb of loop of Henle.
Transporter blocked	Na ⁺ -K ⁺ -2Cl ⁻ cotransporter, NKCC2.
Main physiological result	Loss of medullary gradient and powerful sodium/water diuresis.
Renal impairment	Loop diuretics can still work; higher doses may be required.
Furosemide onset	IV 5-30 minutes; oral 30-60 minutes.
Bumetanide distinction	Higher oral bioavailability than furosemide.
Major electrolyte risk	Hypokalaemia, especially important with concurrent digoxin.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Loop diuretics block NCC in the distal convoluted tubule
- ✓ Loop: NKCC2 in thick ascending limb; thiazides: NCC in distal convoluted tubule
- ✗ Loop diuretics are ineffective in renal impairment
- ✓ They may still work, although higher doses may be needed
- ✗ Loop diuretics do not affect digoxin toxicity risk
- ✓ Loop-induced hypokalaemia increases digoxin toxicity risk

Osmotic Diuretics

Example osmotic diuretic?	Mannitol
Where does it act?	Renal tubule by osmotic effect after glomerular filtration
What is the cerebral effect?	Draws water from brain tissue into plasma, reducing intracranial pressure
What is the dose?	0.25-1 g/kg IV over 15-30 minutes; repeat 4-6 hourly if required
What are the major cautions?	Pulmonary oedema, renal failure, heart failure
What must be monitored?	Electrolytes and osmolality

EXAM TRAPS × tempting option ✓ correct answer

- × Mannitol is a routine diuretic for peripheral oedema
- ✓ Its key role is acute cerebral oedema/raised intracranial pressure
- × Mannitol causes no intravascular volume expansion
- ✓ Initial intravascular volume expansion explains cautions in pulmonary oedema and heart failure
- × Renal failure is not a caution with mannitol
- ✓ Unexcreted mannitol accumulates, worsening fluid and osmotic disturbance

Thiazides

Example drug	Bendroflumethiazide
Site of action	Distal convoluted tubule
Transporter blocked	Na ⁺ -Cl ⁻ co-transporter (NCC)
Main indications	Hypertension; mild heart failure
Potassium effect	Hypokalaemia
Calcium effect	Hypercalcaemia
Important cautions	Gout, diabetes, renal impairment

EXAM TRAPS × tempting option ✓ correct answer

- × Thiazides do not cause hypokalaemia
- ✓ Thiazides cause hypokalaemia, as do loop diuretics
- × Thiazides increase urinary calcium loss
- ✓ Thiazides can cause hypercalcaemia; loop diuretics increase calcium loss
- × Thiazides lower serum uric acid
- ✓ Hyperuricaemia (gout) is a classic thiazide adverse effect
- × Thiazides do not affect digoxin toxicity risk
- ✓ Thiazide-induced hypokalaemia increases susceptibility to digoxin toxicity

Hypertension and Heart Failure

ACE Inhibitors

Example drug	Captopril
Mechanism	Inhibits ACE → reduced angiotensin II and aldosterone; reduced bradykinin breakdown.
Main indications	Hypertension, heart failure, post-MI treatment, diabetic nephropathy.
Renal effect	Efferent arteriolar dilatation → reduced intraglomerular pressure and possible creatinine rise.
Monitoring	Renal function and potassium before and after starting or dose increase.
Major cautions	Bilateral renal artery stenosis, hyperkalaemia, K ⁺ supplements or K ⁺ -sparing diuretics, severe aortic stenosis.
Contra-indications	Bilateral renal artery stenosis, pregnancy, previous ACE inhibitor angioedema.
Classic side-effects	Dry cough, first-dose hypotension, hyperkalaemia, AKI, angioedema.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ ACE inhibitors cannot reduce GFR because they are renoprotective
- ✓ Renoprotective in diabetic nephropathy but can acutely reduce GFR via efferent arteriolar dilatation
- ✗ ACE inhibitor angioedema is an IgE-mediated allergic reaction with urticaria
- ✓ Cough and angioedema are bradykinin-mediated; angioedema can occur without urticaria or allergic trigger
- ✗ ACE inhibitors are safe in bilateral renal artery stenosis
- ✓ Dangerous: glomerular pressure depends on angiotensin II-mediated efferent constriction
- ✗ ACE inhibitors cause hypokalaemia
- ✓ Hyperkalaemia via reduced aldosterone; worsened by potassium supplements or potassium-sparing diuretics

Alpha-Blockers

Main clinical context	Hypertensive crisis in pheochromocytoma
Core rule	Alpha blockade first
Named examples	Phenoxybenzamine, phentolamine
Reason beta-blockers are delayed	Avoid unopposed alpha-mediated vasoconstriction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ In pheochromocytoma, start a beta-blocker first
- ✓ Alpha blockade first (phenoxybenzamine/phentolamine); beta-blockade first causes unopposed alpha vasoconstriction
- ✗ Tachycardia in pheochromocytoma justifies beta-blockade before alpha-blockade
- ✓ Alpha blockade still comes before beta blockade, even with tachycardia

Hypertension

Diagnostic threshold	Clinic $\geq 140/90$ mmHg and ABPM/HBPM $\geq 135/85$ mmHg
Stage 2 threshold	Clinic $\geq 160/100$ mmHg but $< 180/120$ mmHg
Severe threshold	Clinic systolic ≥ 180 mmHg or diastolic ≥ 120 mmHg
Adult target < 80 years	Clinic $< 140/90$ mmHg; ABPM/HBPM $< 135/85$ mmHg
Adult target ≥ 80 years	Clinic $< 150/90$ mmHg; ABPM/HBPM $< 145/85$ mmHg
Emergency indication	Severe BP plus acute end-organ damage
Pregnancy target on treatment	Aim about 135/85 mmHg

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Any BP above 180/120 mmHg is a hypertensive emergency
- ✓ Emergency requires severe BP plus acute end-organ damage
- ✗ ABPM/HBPM use the same thresholds as clinic readings
- ✓ Out-of-clinic values are 5 mmHg lower: diagnosis $\geq 135/85$ mmHg versus clinic $\geq 140/90$ mmHg
- ✗ Retinal haemorrhage or papilloedema is irrelevant to severe hypertension
- ✓ They indicate accelerated/malignant hypertension
- ✗ ACE inhibitors and ARBs are suitable for hypertension in pregnancy
- ✓ ACE inhibitors and ARBs are unsafe in pregnancy; target about 135/85 mmHg on treatment
- ✗ Treatment targets are always based on seated BP

- ✓ With postural hypotension (older or diabetic patients), targets may be based on standing BP

Renin-Angiotensin System Drugs)

Core pathway	Renin → angiotensin I → angiotensin II → aldosterone.
Angiotensin II	Vasoconstriction, sodium and water retention, ADH and thirst stimulation, aldosterone release.
Aldosterone	Sodium and water retention with potassium loss.
Heart failure rationale	Chronic RAAS activation increases preload, afterload and adverse remodelling.
Drug principle	RAAS blockade reduces neurohormonal progression in chronic HFrEF.
Monitoring	Check blood pressure, renal function and potassium before and after initiation or dose increase.
Major risks	Hypotension, renal impairment and hyperkalaemia.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × RAAS activation is always beneficial in heart failure
- ✓ Helps short-term perfusion but chronic activation drives preload, afterload and adverse remodelling
- × ARBs, ARNIs and aldosterone antagonists do not cause hyperkalaemia
- ✓ ACE inhibitors, ARBs, ARNIs and aldosterone antagonists can all cause hyperkalaemia
- × Loop diuretics improve prognosis in HFrEF
- ✓ Loop diuretics relieve congestion; RAAS blockade is disease-modifying in HFrEF
- × Combining multiple RAAS blockers is routinely beneficial
- ✓ Without specialist reason, it increases hypotension, renal impairment and hyperkalaemia risk

Vasodilators Sodium Nitroprusside

Drug action	Second messenger	Vascular effect	Haemodynamic result
NO release	Guanylate cyclase activation and increased cGMP	Arterial and venous smooth muscle relaxation	Reduced afterload and preload

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Sodium nitroprusside is predominantly a venodilator like nitrates
- ✓ It is a balanced arterial and venous dilator, reducing afterload and preload
- × Sodium nitroprusside can be given as an IV bolus
- ✓ IV infusion only
- × Sodium nitroprusside needs only intermittent BP checks
- ✓ Requires continuous arterial blood pressure monitoring
- × Thiocyanate accumulates mainly in hepatic impairment
- ✓ Cyanide risk rises with prolonged infusion and hepatic impairment; thiocyanate accumulates in renal impairment
- × Nitroprusside offers no particular benefit in hypertension with acute LVF
- ✓ Reducing both afterload and preload benefits severe hypertension with acute LVF

Nitrates and Anti-Anginal Drugs

Calcium-Channel Blockers

Verapamil	Rate-limiting CCB; SVT/AF rate control; constipation; avoid with beta-blockers and in heart failure/AV block.
Nifedipine	Dihydropyridine arterial vasodilator; hypertension, angina, Raynaud's; flushing, headache, ankle oedema, reflex tachycardia.
Nimodipine	Cerebral vasodilator; given for 21 days after SAH to prevent/treat vasospasm; hypotension is the key adverse effect.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All calcium-channel blockers are rate-limiting
- ✓ Verapamil is rate-limiting; nifedipine and nimodipine are predominantly vascular
- × Nimodipine is a routine antihypertensive
- ✓ Given for 21 days after SAH to prevent/treat cerebral vasospasm
- × Short-acting nifedipine is appropriate in ischaemic heart disease
- ✓ Avoid short-acting nifedipine in ischaemic heart disease

Nitrates

Example drug	Glyceryl trinitrate (GTN)
Mechanism	NO donor → guanylate cyclase activation → increased cGMP → vascular smooth muscle relaxation
Main haemodynamic effect	Primarily venodilation → reduced preload → reduced cardiac work and O ₂ demand
Higher-dose effect	Additional arterial dilation → reduced afterload and BP
Acute route	Sublingual tablet or spray; onset 1-3 minutes; duration 20-30 minutes
Prophylaxis route	Transdermal patch, with nitrate-free period
Acute monitored route	Intravenous infusion
Key side-effects	Headache, flushing, hypotension, reflex tachycardia, methaemoglobinaemia at high doses
Major contraindication	Concurrent PDE5 inhibitors such as sildenafil

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × GTN is primarily an arterial dilator at anti-anginal doses
- ✓ Primarily a venodilator, reducing preload; arterial dilation occurs at higher doses
- × Continuous nitrate exposure maintains full effect
- ✓ Continuous exposure causes tolerance; a nitrate-free period is required
- × GTN can be safely given with sildenafil
- ✓ Absolute contraindication: PDE5 inhibitors with GTN cause severe hypotension
- × Headache is the major limiting adverse effect of GTN
- ✓ Hypotension is the major limiting adverse effect

Sympathomimetics

Inotropic Sympathomimetics

When used	Cardiogenic shock or acute decompensated heart failure when cardiac output remains inadequate despite fluid resuscitation
Class limitation	Increased myocardial oxygen demand, worsening ischaemia, tachyarrhythmias, tolerance
Dobutamine	Primarily beta-1 agonist; some beta-2 vasodilation; minimal alpha effect
Dopamine	Dose-dependent: D1/D2 at low dose, beta-1 at medium dose, alpha-1 at high dose

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Dopamine is purely an inotrope at all doses
- ✓ At high doses it is predominantly an alpha-1 vasoconstrictor
- × Low-dose 'renal-dose' dopamine prevents acute kidney injury
- ✓ Renal-dose dopamine does not prevent acute kidney injury
- × Positive inotropes reduce myocardial ischaemia
- ✓ Inotropy increases myocardial oxygen demand and can worsen ischaemia

Vasoconstrictor Sympathomimetics

Class effect	Peripheral vasoconstriction
Main receptor	Alpha-1 adrenergic receptor
Haemodynamic result	Increased systemic vascular resistance and blood pressure
Named examples	Ephedrine and metaraminol

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Higher blood pressure from vasoconstrictors guarantees better tissue perfusion
- ✓ Vasoconstriction may raise pressure while cardiac output remains inadequate
- × Vasoconstrictors such as metaraminol primarily increase contractility
- ✓ Vasoconstrictors raise vascular tone (alpha-1); inotropes increase contractility

Anticoagulants

Oral Anticoagulants

Main drug	Warfarin
Mechanism	Vitamin K antagonist; reduces functional II, VII, IX, X and proteins C/S
Monitoring	INR
Common target	2.0-3.0 for AF, DVT and PE
Mechanical valve target	Often 2.5-3.5, depending on valve and specialist plan
Onset	Delayed: about 2-3 days
Urgent reversal	IV vitamin K
Life-threatening bleeding	PCC plus IV vitamin K; FFP if PCC unavailable or advised
Key interactions	Inducers lower INR; inhibitors raise INR
Major adverse effect	Bleeding

Pregnancy	Contraindicated/avoid; specialist anticoagulation required
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EXAM TRAPS × tempting option ✓ correct answer

- × Warfarin anticoagulates immediately
- ✓ Effect is delayed about 2-3 days while circulating clotting factors clear
- × IV vitamin K alone gives immediate warfarin reversal
- ✓ Vitamin K is not instant; PCC is needed for immediate reversal in life-threatening bleeding
- × Rifampicin and carbamazepine increase the INR
- ✓ Inducers (rifampicin, carbamazepine, phenytoin) reduce INR; amiodarone, metronidazole, fluconazole, erythromycin increase INR
- × Patients on warfarin must avoid leafy vegetables completely
- ✓ Advise consistent vitamin K intake rather than avoidance
- × Warfarin is safe in pregnancy
- ✓ Warfarin crosses the placenta and is teratogenic; avoid in pregnancy

Parenteral Anticoagulants

Unfractionated heparin	Antithrombin III activation; inhibits IIa and Xa; IV infusion or SC; monitor APTT; reversible with protamine; usable in renal impairment.
Enoxaparin	LMWH type example; preferential Xa inhibition; usually SC (IV bolus in some ACS protocols); predictable effect; no routine monitoring; accumulates in renal impairment; partial protamine reversal.
Protamine sulphate	Specific UFH antagonist; ionic binding to heparin; 1 mg per 100 units recent UFH, max 50 mg; slow IV under monitoring; hypotension, bradycardia, anaphylaxis.

EXAM TRAPS × tempting option ✓ correct answer

- × Heparin dissolves existing clot
- ✓ Heparin prevents clot extension; it is not a fibrinolytic
- × Protamine fully reverses LMWH
- ✓ Protamine fully reverses UFH but only partially reverses LMWH
- × Enoxaparin is preferred over UFH in severe renal impairment
- ✓ UFH is often safer; enoxaparin accumulates in renal impairment
- × A falling platelet count in HIT means low thrombosis risk
- ✓ HIT is prothrombotic despite a falling platelet count

Principles of Management of Thromboembolic Disease

Main purpose	Prevent clot propagation and future embolic events.
Treatment examples	DVT, PE, ACS and acute high-risk thrombosis.
Prophylaxis examples	AF stroke prevention, prosthetic valves and VTE prevention in high-risk immobility.
Treatment dose	Higher-intensity anticoagulation for known or suspected thrombosis.
Prophylactic dose	Preventive anticoagulation; lower intensity for short-term VTE prevention, or indication-specific long-term prevention.
Main hazard	Bleeding; risk increases with intensity, renal impairment, interacting drugs and frailty.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anticoagulants actively break down existing clot
- ✓ Anticoagulants stop clot extension; thrombolytics promote fibrin breakdown
- ✗ AF anticoagulation treats an existing atrial clot in most patients
- ✓ It is thromboprophylaxis against embolic stroke
- ✗ Prophylactic anticoagulation uses treatment-intensity dosing without risk assessment
- ✓ Prophylaxis is lower intensity and should be justified by risk assessment
- ✗ ACS treatment is antiplatelet-only
- ✓ Anticoagulation also limits thrombus propagation in ACS pathways

Antiplatelet Drugs

Overview

What is the final common receptor for platelet aggregation?	Glycoprotein IIb/IIIa.
What bridges adjacent platelets?	Fibrinogen.
Which antiplatelet class blocks this final common pathway?	Glycoprotein IIb/IIIa inhibitors.
When are these agents relevant in NSTEMI?	High-risk NSTEMI patients undergoing PCI, with aspirin and heparin.
What is the main adverse effect?	Bleeding.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ GPIIb/IIIa inhibitors are routine therapy for all NSTEMI patients
- ✓ Reserved for high-risk NSTEMI undergoing PCI, with aspirin and heparin
- ✗ GPIIb/IIIa inhibitors act by blocking COX-1 or P2Y₁₂
- ✓ They block GPIIb/IIIa, preventing fibrinogen bridging of platelets
- ✗ Combining antiplatelets with anticoagulants does not add bleeding risk
- ✓ The combination increases bleeding risk

Specific Drugs

Drug	Class / target	Key mechanism	Main uses required	Major risk or caution
Abciximab	GPIIb/IIIa inhibitor	Blocks platelet GPIIb/IIIa receptor, preventing fibrinogen cross-linking	Adjunct in NSTEMI/ACS patients undergoing PCI	Bleeding complications
Aspirin	COX inhibitor	Irreversibly inhibits COX-1/COX-2, reducing thromboxane A ₂ and platelet aggregation	ACS, ischaemic stroke, long-term antiplatelet therapy	GI irritation/ulceration, bleeding, bronchospasm in aspirin-sensitive asthma; avoid in children <16

Drug	Class / target	Key mechanism	Main uses required	Major risk or caution
Clopidogrel	P2Y ₁₂ ADP receptor antagonist	Irreversibly inhibits ADP-mediated platelet activation and aggregation	ACS with aspirin, ischaemic stroke/TIA, peripheral arterial disease, post-coronary stent	Bleeding; interaction with omeprazole and other CYP2C19-inhibiting PPIs

Aspirin doses	75 mg once daily for antiplatelet use; 300 mg loading in ACS or ischaemic stroke; 300-900 mg analgesic/antipyretic dose.			
Clopidogrel mechanism	Irreversible P2Y ₁₂ ADP receptor antagonist; prodrug requiring CYP2C19 activation.			
Clopidogrel doses	300 mg loading dose, or 600 mg for faster onset; 75 mg once daily maintenance.			

EXAM TRAPS × tempting option ✓ correct answer

- × Aspirin 75 mg is the loading dose in ACS
- ✓ 300 mg is the loading dose in ACS and ischaemic stroke; 75 mg is long-term antiplatelet dosing
- × Aspirin is suitable for children under 16
- ✓ Avoid in children under 16 because of Reye's syndrome risk
- × Omeprazole enhances clopidogrel effect
- ✓ CYP2C19 inhibition reduces activation of the prodrug clopidogrel, reducing its effect
- × GPIIb/IIIa inhibitors are routine ACS drugs
- ✓ Adjuncts only for selected high-risk NSTEMI/ACS patients undergoing PCI

Myocardial Infarction and Fibrinolysis

Fibrinolytics

Core mechanism	Plasminogen activation → plasmin → fibrin clot breakdown
Main ED indication	STEMI when primary PCI is not available within the required timeframe
Major risk	Bleeding, especially intracranial haemorrhage
Streptokinase	Non-fibrin-specific; antigenic; do not repeat within 12 months
Tenecteplase	Modified tPA; fibrin-specific; single IV bolus
Reteplase	Recombinant tPA; fibrin-specific; two IV boluses 30 minutes apart

EXAM TRAPS × tempting option ✓ correct answer

- × Fibrinolytics mainly prevent further clot propagation
- ✓ Fibrinolytics break down clot via plasmin; anticoagulants prevent propagation
- × Fibrinolysis is indicated for NSTEMI
- ✓ Not for NSTEMI; indicated for STEMI when primary PCI is unavailable in time
- × Streptokinase can be safely repeated within 12 months
- ✓ Streptokinase is antigenic; allergic reactions occur, so do not repeat within 12 months
- × Aortic dissection is not a contraindication to thrombolysis
- ✓ Aortic dissection is a contraindication; thrombolysis can be catastrophic

Lipid-Regulating Drugs

Statins

Class	Lipid-regulating drugs
Mechanism	HMG-CoA reductase inhibition → reduced hepatic cholesterol synthesis → increased LDL receptors
Main indication	Primary and secondary prevention of cardiovascular events
Contra-indications	Active liver disease, pregnancy, lactation
Cautions	Hepatic impairment, hypothyroidism, interacting drugs
Key interaction	CYP3A4 inhibitors such as macrolides increase myopathy risk with some statins
Major toxicity	Myopathy and rhabdomyolysis causing possible acute kidney injury
Monitoring trigger	Check CK if significant muscle symptoms occur; monitor LFTs when clinically indicated

 **EXAM TRAPS** × tempting option ✓ correct answer

- × Statins act as acute anti-anginal or thrombolytic drugs
- ✓ Statins reduce cardiovascular risk over time via HMG-CoA reductase inhibition
- × Hypothyroidism does not affect statin myopathy risk
- ✓ Hypothyroidism is a reversible risk factor for statin-associated myopathy
- × Macrolides do not interact with simvastatin
- ✓ CYP3A4-inhibiting macrolides increase myopathy risk with some statins, classically simvastatin

Drugs Used in Resuscitation

Adrenaline (Epinephrine)

Drug class	Endogenous catecholamine; mixed alpha and beta adrenoceptor agonist
Main cardiac arrest effect	Alpha-1 vasoconstriction increases coronary and cerebral perfusion pressure
Beta effects	Increased heart rate and contractility; bronchodilation
Adult ALS dose	1 mg IV/IO every 3-5 minutes
Shockable rhythm timing	After the third shock
Non-shockable rhythm timing	As soon as IV/IO access is available
Adult anaphylaxis IM dose	0.5 mg = 500 micrograms = 0.5 mL of 1:1000
Severe anaphylaxis IV dose	50 micrograms IV boluses, titrated by experienced clinicians with monitoring
Key adverse effects	Tachycardia, hypertension, anxiety, headache, ventricular arrhythmias

EXAM TRAPS × tempting option ✓ correct answer

- ✗ In shockable arrest, give adrenaline before the first shock
- ✓ Give 1 mg after the third shock in shockable rhythms
- ✗ In non-shockable arrest, delay adrenaline until after several CPR cycles
- ✓ Give 1 mg IV/IO as soon as IV/IO access is available
- ✗ Adult anaphylaxis is treated with 1 mg IV/IO adrenaline
- ✓ Anaphylaxis: 0.5 mg IM; cardiac arrest: 1 mg IV/IO
- ✗ IV adrenaline is routine first-line anaphylaxis treatment
- ✓ IM adrenaline is preferred for most patients

Amiodarone (in resuscitation)

ALS indication	VF/pulseless VT after repeated shocks
First arrest dose	300 mg IV/IO after the third shock
Second arrest dose	150 mg IV/IO after the fifth shock if VF/pVT persists or recurs
Not for	Routine use in PEA or asystole
Core mechanism	K ⁺ channel blockade → prolonged action potential and refractory period
ECG effect	QT prolongation
Major acute adverse effects	Hypotension, bradycardia, phlebitis, pro-arrhythmia
Key interactions	Warfarin, digoxin, QT-prolonging drugs

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Amiodarone is given in PEA/asystole
- ✓ Amiodarone is for shockable rhythms (VF/pVT) only, not PEA or asystole
- ✗ Amiodarone in arrest is given as 300 mg over 20-60 minutes then 900 mg over 24 h
- ✓ Arrest: 300 mg IV/IO bolus after third shock, 150 mg after fifth; infusion is for stable tachyarrhythmia
- ✗ Amiodarone is a pure Class III drug
- ✓ Additional Class I, II and IV effects explain its broad anti-arrhythmic activity
- ✗ Amiodarone interactions are irrelevant after ROSC
- ✓ Watch for QT prolongation and interactions with warfarin and digoxin

Atropine

Class	Antimuscarinic; competitive muscarinic receptor antagonist
Main cardiac receptor	M2 receptor
Main cardiac effect	Blocks vagal tone, increasing SA node rate and AV nodal conduction
Dose	500 micrograms IV; repeat to maximum total 3 mg

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Atropine is a sympathomimetic vasopressor
- ✓ Atropine is an antimuscarinic removing vagal (M2) inhibition; adrenaline is the sympathomimetic
- ✗ Atropine is routine treatment for PEA/asystole
- ✓ Atropine is not routinely given in PEA/asystole in ALS
- ✗ Atropine is reliable treatment for complete heart block
- ✓ Unreliable; unstable patients usually need pacing

PHARMACOLOGY · TOPIC 3 OF 10

Respiratory System

Antihistamines (Respiratory)

Allergic Emergencies

First-line drug	Adrenaline
Preferred route	IM into anterolateral thigh
Adult dose	0.5 mg IM = 0.5 mL of 1:1000
Repeat dosing	Repeat after 5 minutes if no improvement
IV adrenaline	Specialist monitored use only, or cardiac arrest/circulatory collapse context
Adjuncts	IV fluids, nebulised salbutamol; chlorphenamine for skin symptoms after stabilisation; corticosteroids not routine

EXAM TRAPS × tempting option ✓ correct answer

- × Chlorphenamine or hydrocortisone is first-line anaphylaxis treatment
- ✓ IM adrenaline is first-line; these are adjuncts and must not delay adrenaline
- × IV adrenaline is routine in anaphylaxis
- ✓ IM is preferred; IV only in cardiac arrest, peri-arrest collapse or specialist monitored titration
- × Adrenaline's beta-2 effect in anaphylaxis is bronchodilation only
- ✓ Beta-2 effects also reduce mast cell mediator release
- × Anaphylaxis always presents with a rash
- ✓ Anaphylaxis may occur without obvious skin signs

Antihistamines Overview

Mechanism	Competitive H1 receptor antagonism
Sedation mechanism	Central H1 blockade after blood-brain barrier penetration
Non-sedating example	Cetirizine: second-generation; allergic rhinitis, urticaria, hay fever
Sedating example	Chlorpheniramine: first-generation; allergic reactions, urticaria, anaphylaxis adjunct
Chlorpheniramine cautions	Elderly patients, prostatic hypertrophy, angle-closure glaucoma

EXAM TRAPS × tempting option ✓ correct answer

- × Chlorphenamine is the treatment for anaphylaxis
- ✓ Adrenaline is the first-line life-saving drug; chlorphenamine is an adjunct
- × Non-sedating antihistamines never cause drowsiness
- ✓ They are relatively non-sedating because CNS penetration is low
- × First-generation antihistamines cause sedation only
- ✓ They also cause antimuscarinic adverse effects

Bronchodilators

Antimuscarinics

Example drug	Ipratropium
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Mechanism	M3 muscarinic receptor antagonism blocks vagal bronchoconstriction
Asthma role	Adjunct to salbutamol in severe/life-threatening attacks
COPD role	Nebulised bronchodilator in exacerbations
Dose in severe asthma	500 micrograms nebulised every 4-6 hours
Dose in COPD	500 micrograms nebulised
Main cautions	Angle-closure glaucoma; prostate hypertrophy

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Ipratropium can replace salbutamol in acute severe asthma
- ✓ Ipratropium is an adjunct to salbutamol
- ✗ Hypokalaemia and tremor are antimuscarinic adverse effects
- ✓ Hypokalaemia and tremor suggest beta-2 agonists; dry mouth and urinary retention suggest antimuscarinics
- ✗ Nebulised ipratropium poses no risk in angle-closure glaucoma
- ✓ Ocular exposure from the nebuliser mask can precipitate angle-closure glaucoma

Selective Beta-2 Agonists

Example drug	Salbutamol.
Class	Short-acting beta-2 agonist.
Mechanism	Beta-2 agonism → bronchial smooth muscle relaxation → bronchodilation.
Routes	MDI/spacer, nebulised, IV.
Nebulised acute severe asthma dose	2.5-5 mg every 20-30 minutes, or continuously.
IV acute severe asthma dose	250 micrograms slow IV if inhaled route not possible.
Key toxicity	Tachycardia, tremor and hypokalaemia.
Monitoring emphasis	Potassium in severe attacks, especially with repeated or IV treatment.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Beta-2 selectivity means salbutamol has no cardiac effects
- ✓ Selectivity is relative; tachycardia is common at high doses
- ✗ Salbutamol causes hypokalaemia by increasing renal potassium loss
- ✓ It shifts potassium into cells
- ✗ Salbutamol replaces corticosteroids in acute asthma
- ✓ Salbutamol relieves bronchospasm but is not anti-inflammatory; corticosteroids are still needed

Theophylline

Drug example	Aminophylline
Composition	Theophylline + ethylenediamine
Mechanism	PDE inhibition → increased cAMP → bronchodilation; adenosine receptor antagonism
Therapeutic range	10-20 mg/L
Toxic level	>20 mg/L
Asthma role	IV use in life-threatening or near-fatal asthma refractory to inhaled therapy
Toxicity	Nausea/vomiting, tachycardia, arrhythmias, hypotension, seizures

Interactions	Inducers reduce levels; inhibitors increase levels
Key safety step	Check theophylline level before IV aminophylline if already taking oral theophylline

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Aminophylline is routine acute asthma therapy
- ✓ Escalation only in severe, life-threatening or near-fatal asthma when inhaled therapy is inadequate
- ✗ Theophylline has a wide therapeutic index
- ✓ Narrow: therapeutic 10-20 mg/L; toxic above 20 mg/L
- ✗ Ciprofloxacin and erythromycin reduce theophylline levels
- ✓ Rifampicin, phenytoin, carbamazepine reduce levels; cimetidine, ciprofloxacin, erythromycin increase levels

Corticosteroids (Respiratory)

Respiratory Corticosteroids

Core mechanism	Anti-inflammatory airway effect: reduced oedema, reduced secretions and restored beta-2 receptor sensitivity.
Acute severe asthma	Hydrocortisone 100 mg IV 6-hourly.
Preventer therapy	Beclomethasone inhaled corticosteroid; minimum effective dose.
Local inhaled adverse effects	Oral candidiasis and dysphonia.
Systemic adverse effects	Adrenal suppression, osteoporosis, skin thinning and immunosuppression with high-dose or prolonged exposure.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Inhaled corticosteroids act as immediate bronchodilators
- ✓ Main value is anti-inflammatory airway control, not immediate bronchodilation
- ✗ Beclomethasone is suitable as an acute reliever inhaler
- ✓ Beclomethasone is prophylactic (preventer) therapy, not a reliever

Oxygen

Oxygen Therapy

Main purpose	Correct or prevent clinically important hypoxaemia
Most patients	Target SpO ₂ 94-98%
Risk of hypercapnic respiratory failure	Target SpO ₂ 88-92%
Key COPD risk	Excess oxygen may worsen CO ₂ retention and respiratory acidosis
Monitoring limitation	SpO ₂ assesses oxygenation, not ventilation

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A normal SpO₂ excludes hypercapnia
- ✓ Normal SpO₂ does not exclude hypercapnia; SpO₂ assesses oxygenation, not ventilation
- ✗ Target SpO₂ 94-98% in a known CO₂ retainer
- ✓ Target 88-92% in known CO₂ retainers unless blood gases and senior guidance support otherwise
- ✗ Oxygen-induced hypercapnia in COPD is due solely to loss of hypoxic drive
- ✓ V/Q mismatch and the Haldane effect also contribute, not just hypoxic drive
- ✗ Anaemia causes a low PaO₂ and low SpO₂
- ✓ Anaemia reduces oxygen content but PaO₂ and SpO₂ may remain relatively normal

PHARMACOLOGY · TOPIC 4 OF 10

Central Nervous System

Analgesics

Non-Opioid Analgesics

Aspirin	COX-1/COX-2 inhibition; reduced prostaglandins; analgesic/antipyretic dose 300-900 mg every 4-6 hours; avoid in children under 16 years.
Paracetamol	Analgesic and antipyretic, not anti-inflammatory; 500 mg-1 g every 4-6 hours; maximum 4 g/day in most adults; oral, rectal and IV routes.
Paracetamol overdose	NAPQI accumulation after glutathione depletion causes centrilobular hepatic necrosis; early symptoms may be mild; liver failure typically evolves over 24-72 hours and peaks at 72-96 hours.
NAC	Intravenous acetylcysteine replenishes glutathione and is guided by the paracetamol poisoning treatment graph and clinical context.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Paracetamol is an anti-inflammatory drug
- ✓ Paracetamol is analgesic and antipyretic but not anti-inflammatory
- ✗ A well-looking patient soon after paracetamol overdose is reassuring
- ✓ Hepatotoxicity is delayed; early symptoms may be mild despite serious overdose
- ✗ Aspirin is suitable for analgesia or fever in children under 16
- ✓ Avoid aspirin under 16 years because of Reye's syndrome risk
- ✗ Aspirin analgesic dose is the same as its antiplatelet dose
- ✓ Analgesic dose is 300-900 mg every 4-6 hours, distinct from low-dose antiplatelet use

Opioid Analgesics

Drug	Core Mechanism	Main Uses	Key Risk
Morphine salts	Mainly mu opioid receptor agonist	Moderate-severe pain; not routine in acute pulmonary oedema	Respiratory depression
Codeine phosphate	CYP2D6 prodrug converted to morphine	Mild-moderate pain; antitussive; antidiarrhoeal	Variable metabolism and opioid toxicity
Tramadol	Weak mu agonist plus NA/5-HT reuptake inhibition	Moderate pain	Seizures and serotonin syndrome

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All opioids share identical cautions
- ✓ Tramadol carries additional seizure and serotonin syndrome risks (noradrenaline/serotonin reuptake inhibition)
- × Codeine has a predictable effect independent of metabolism
- ✓ Codeine is a CYP2D6 prodrug; variable metabolism causes lack of effect or toxicity
- × Naloxone should be given to achieve complete opioid reversal
- ✓ Titrate naloxone to restore adequate respiration, not complete reversal
- × Morphine is safe at normal doses in renal failure
- ✓ Morphine metabolites accumulate in renal failure, causing toxicity

Antiepileptics

Antiepileptics (Maintenance)

Carbamazepine	Na ⁺ channel blocker; enzyme inducer; monitor FBC, LFTs and sodium; beware rash and SIADH.
Phenytoin	Na ⁺ channel blocker; therapeutic range 10-20 mg/L; zero-order kinetics; toxicity causes nystagmus, ataxia and slurred speech.
Sodium valproate	Broad-spectrum; enhances GABA and blocks Na ⁺ channels; enzyme inhibitor; high teratogenic risk; monitor LFTs and FBC.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Sodium valproate is an enzyme inducer
- ✓ Valproate inhibits enzymes; carbamazepine and phenytoin induce enzymes
- × Phenytoin levels rise proportionally with dose increases
- ✓ Phenytoin has zero-order kinetics; a small dose increase can cause toxicity
- × IV phenytoin can be given rapidly without monitoring
- ✓ IV phenytoin requires slow administration with ECG monitoring
- × Valproate teratogenicity is a minor concern
- ✓ Valproate causes neural tube defects, major malformations and neurodevelopmental effects; high teratogenic risk
- × Hyponatraemia on carbamazepine is due to an unrelated cause
- ✓ SIADH is a recognised adverse effect of carbamazepine

Status Epilepticus

- Early benzodiazepine therapy is the first pharmacological step in status epilepticus.
- Lorazepam 4 mg IV bolus is the preferred first-line option; diazepam and midazolam are important alternatives when IV access is unavailable.
- If seizures persist after two benzodiazepine doses, give IV levetiracetam, phenytoin (20 mg/kg, max 50 mg/min with ECG monitoring) or sodium valproate.
- Fosphenytoin is a pro-drug alternative that can be given faster and may be administered IM.
- Refractory status epilepticus requires ITU-level escalation; paraldehyde, phenobarbital, propofol and midazolam infusion are relevant options.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Benzodiazepines should be repeated until seizures stop
- ✓ After two benzodiazepine doses, give second-line therapy (levetiracetam, phenytoin or valproate)
- × IV phenytoin can be given as a rapid bolus
- ✓ Give slowly (max 50 mg/min) with ECG monitoring; rapid administration risks hypotension and arrhythmias
- × Midazolam requires IV access to be effective
- ✓ Midazolam can be given buccally or IM, so is useful without IV access
- × Paraldehyde can be given using standard plastic syringes over time
- ✓ Paraldehyde dissolves plastic; use glass equipment or prepare immediately before use

Antimanic Drugs

Lithium

Drug class	Antimanic mood stabiliser.
Main exam issue	Narrow therapeutic index and toxicity recognition.
Prophylaxis range	0.4-1.0 mmol/L.
Acute mania range	0.8-1.0 mmol/L.
Toxic level	>1.5 mmol/L.
Life-threatening level	>2.0 mmol/L.
Monitoring	Serum lithium, renal function and thyroid function.
Risk factors for high levels	Dehydration, low-sodium diet, NSAIDs, ACE inhibitors, thiazide diuretics and renal impairment.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Lithium toxicity can be predicted from dose alone
- ✓ Lithium toxicity is concentration- and context-dependent
- × Lithium concentration near the therapeutic range excludes toxicity
- ✓ Dehydration and renal impairment can make toxicity clinically significant even near therapeutic range
- × Thiazide diuretics do not affect lithium levels
- ✓ Thiazides cause sodium loss, promoting lithium retention and toxicity

Antipsychotics

Antipsychotics Overview

Main receptor principle	D2 receptor blockade
EPS pathway	Nigrostriatal dopamine blockade in the striatum
Acute dystonia	Hours to days; oculogyric crisis, torticollis, opisthotonus; procyclidine IV/IM
Akathisia	Subjective restlessness; can mimic agitation or psychosis
Parkinsonism	Bradykinesia, rigidity and tremor; usually weeks later
Tardive dyskinesia	Late oro-facial dyskinesia; potentially irreversible
Atypical antipsychotics	Lower EPS risk due to lower D2 affinity/effect and/or 5-HT _{2A} blockade
NMS	Hyperthermia, rigidity, altered consciousness and autonomic instability

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Akathisia on antipsychotics indicates worsening psychosis
- ✓ Akathisia is an extrapyramidal adverse effect that can mimic agitation or psychosis
- × Acute dystonia occurs only after weeks of antipsychotic therapy
- ✓ Acute dystonia occurs rapidly, within hours to days of exposure
- × Focal acute dystonia is a form of neuroleptic malignant syndrome
- ✓ NMS is systemic: hyperthermia, rigidity, altered consciousness and autonomic instability
- × Tardive dyskinesia is a reversible acute extrapyramidal effect
- ✓ Tardive dyskinesia is a late effect that may be persistent or irreversible

Drugs Used in Nausea and Vertigo

Anti-emetics Overview

Drug	Class/mechanism	Uses	Key cautions and adverse effects
Cyclizine	H1 antihistamine with antimuscarinic activity	Nausea and vomiting, motion sickness; oral, IV, IM or SC routes	Sedation and antimuscarinic effects; avoid or use caution in heart failure because IV use may cause tachycardia and hypotension
Prochlorperazine	Phenothiazine; D2 antagonist at the chemoreceptor trigger zone, also H1 and muscarinic antagonism	Nausea, vomiting and vertigo from labyrinthine disorders; oral, buccal, IM or IV routes	EPS including oculogyric crisis, sedation, postural hypotension; caution in Parkinson's disease, epilepsy and older patients
Metoclopramide	D2 antagonist at the chemoreceptor trigger zone; prokinetic effect increasing gastric emptying and lower oesophageal sphincter tone	Nausea and vomiting, post-operative or chemotherapy-related nausea, gastroparesis and gastric stasis; oral, IV or IM routes	EPS especially in children, young adults and older patients; avoid in GI obstruction or perforation and Parkinson's disease; restricted in under-18s; maximum 5 days

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All anti-emetics are equally effective for any cause of nausea
- ✓ Vestibular nausea responds to antihistamines; CTZ-mediated nausea is targeted by D2 antagonists
- × Oculogyric crisis after metoclopramide needs only reassurance
- ✓ It is acute dystonia; treat with procyclidine
- × Metoclopramide is appropriate in gastrointestinal obstruction
- ✓ Its prokinetic action makes it inappropriate in GI obstruction or perforation, though useful in gastric stasis
- × Prochlorperazine and metoclopramide are safe in Parkinson's disease
- ✓ Their dopamine (D2) blockade can worsen parkinsonian symptoms

Hypnotics and Anxiolytics

Benzodiazepines Overview

Mechanism	Enhance GABA-A receptor activity; increased chloride influx causes neuronal hyperpolarisation.
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Withdrawal	Anxiety, insomnia, tremor, sweating and seizures; reduce gradually rather than stopping abruptly.
Chronic anxiety	Not recommended for long-term use because tolerance and dependence develop rapidly.
Diazepam	Long acting; oral, IV and rectal; active metabolites last for days.
Chlordiazepoxide	Long acting; oral only; key use is alcohol withdrawal management.
Lorazepam	Short-to-intermediate acting; IV, IM and sublingual; no active metabolites and reliable IM absorption.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Benzodiazepines directly open GABA-A chloride channels
- ✓ They enhance the effect of GABA at GABA-A receptors
- ✗ Established benzodiazepines can be stopped abruptly
- ✓ Abrupt withdrawal can cause seizures; reduce gradually
- ✗ Benzodiazepines are suitable long-term treatment for chronic anxiety
- ✓ Tolerance and dependence develop rapidly, limiting long-term use
- ✗ Lorazepam has active metabolites; diazepam has none
- ✓ Diazepam has active metabolites; lorazepam has none and reliable IM absorption

Tricyclic Antidepressants

Amitriptyline

Drug class	Tricyclic antidepressant
Key dangerous mechanism	Myocardial fast sodium-channel blockade
Antimuscarinic features	Dry mouth, urinary retention, dilated pupils, tachycardia, blurred vision, hyperthermia, ileus
CNS features	Sedation, seizures, coma
Cardiac features	QRS prolongation, QT prolongation, VT/VF, hypotension
QRS thresholds	>100 ms significant; >160 ms high arrhythmia risk
Specific treatment trigger	Sodium bicarbonate for QRS widening or arrhythmias
Avoid	Physostigmine

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Amitriptyline overdose is a simple sedative overdose
- ✓ Myocardial fast sodium-channel blockade is the key life-threatening mechanism
- ✗ The ECG adds little to risk assessment in TCA overdose
- ✓ QRS duration is central to risk assessment (>100 ms significant; >160 ms high arrhythmia risk)
- ✗ Physostigmine is used for antimuscarinic features in TCA overdose
- ✓ Physostigmine should be avoided in TCA overdose
- ✗ QT prolongation is the trigger for sodium bicarbonate in TCA overdose
- ✓ QRS widening reflects sodium-channel blockade and triggers sodium bicarbonate

Infections

Antibacterial Drugs

Aminoglycosides

Type example	Gentamicin
Mechanism	30S binding; mRNA misreading; bactericidal
Killing pattern	Concentration-dependent
Spectrum	Aerobic Gram-negative organisms including E. coli, Pseudomonas and Klebsiella
Uses	Serious Gram-negative infection, pyelonephritis, septicaemia, endocarditis synergy
Monitoring	Peak and trough levels; trough relates especially to toxicity
Major toxicities	Nephrotoxicity and irreversible ototoxicity
Key cautions	Renal impairment, elderly patients, myasthenia gravis

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Aminoglycosides are bacteriostatic
- ✓ Gentamicin is bactericidal (30S binding, mRNA misreading)
- × Gentamicin toxicity relates primarily to peak levels
- ✓ Trough accumulation is the key toxicity concern

Cephalosporins

Class	Beta-lactam antibacterial drugs
Mechanism	Bind PBPs and inhibit peptidoglycan cross-linking
Effect	Bactericidal cell-wall weakening and osmotic lysis
Allergy point	Possible cross-allergy with penicillins; use caution
1st generation example	Cefalexin: oral; MSSA and streptococci; skin/soft tissue infection and UTI
2nd generation example	Cefuroxime: IV/oral; broader gram-negative cover; pneumonia, UTI, surgical prophylaxis
3rd generation examples	Cefotaxime and ceftriaxone: broad gram-negative cover and CNS penetration

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Cephalosporins have a different mechanism from penicillins
- ✓ Both are beta-lactams binding PBPs and inhibiting peptidoglycan cross-linking
- × Cephalosporins are automatically safe in all penicillin-allergic patients
- ✓ Cross-allergy with penicillins is possible; use caution
- × Cefalexin is a later-generation IV cephalosporin
- ✓ Cefalexin is oral, first generation, used for MSSA and streptococcal skin infection

Macrolides

Mechanism	50S ribosomal binding; inhibits translocation; bacteriostatic.
Type example	Erythromycin.
Routes	Oral and IV.

Major uses	Atypical pneumonia, penicillin-allergy alternative, chlamydia, whooping cough and <i>Campylobacter</i> .
Main adverse effects	GI disturbance, QT prolongation, cholestatic jaundice, high-dose IV ototoxicity.
Key interactions	CYP3A4 inhibition increases warfarin, statins, theophylline and digoxin levels.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Macrolides act at the 30S ribosomal subunit
- ✓ Macrolides act at 50S; tetracyclines and aminoglycosides act at 30S
- ✗ Erythromycin GI upset is an allergic reaction
- ✓ Erythromycin commonly causes GI symptoms via motilin receptor stimulation
- ✗ QT prolongation is not a concern with macrolides
- ✓ QT prolongation is a class safety issue, especially with other QT-prolonging drugs

Management of Tuberculosis

Initial phase	Rifampicin, isoniazid, pyrazinamide, ethambutol for 2 months – RIPE.
Continuation phase	Rifampicin and isoniazid for months 3-6.
Pregnancy	Treat active TB; current UK standard treatment includes first-line drugs. Avoid streptomycin.
Breastfeeding	Generally compatible with first-line TB drugs; infant exposure risk still needs assessment.
Liver monitoring	Baseline and ongoing LFTs; hepatotoxicity is especially relevant with isoniazid, rifampicin and pyrazinamide.
Renal/visual monitoring	Ethambutol accumulates in renal impairment and can cause optic neuritis; monitor renal function and vision.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The initial phase of TB treatment uses two drugs
- ✓ Initial phase uses four drugs (RIPE) for 2 months
- ✗ The continuation phase uses all four RIPE drugs
- ✓ Continuation phase is rifampicin plus isoniazid for months 3-6
- ✗ Ethambutol has no visual toxicity
- ✓ Ethambutol causes optic neuritis, especially when it accumulates in renal impairment
- ✗ Breastfeeding contra-indicates first-line TB treatment
- ✓ First-line TB drugs are generally compatible with breastfeeding
- ✗ Streptomycin is acceptable for TB in pregnancy
- ✓ Avoid streptomycin in pregnancy because of fetal ototoxicity

Other Antibiotic Agents

Drug	Mechanism	Must-know clinical point
Chloramphenicol eye preparations	Protein synthesis inhibitor.	Topical ocular use; systemic use restricted due to aplastic anaemia.
Fusidic acid	Inhibits elongation factor G.	Anti-staphylococcal; combine systemically to prevent resistance.
Vancomycin	Binds D-Ala-D-Ala and inhibits cell wall synthesis.	Gram-positive only; MRSA; monitor levels; slow IV infusion.

Drug	Mechanism	Must-know clinical point
Metronidazole	Anaerobic reduction produces DNA-damaging radicals.	Anaerobes and protozoa; avoid alcohol; increases warfarin effect.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Vancomycin is a broad-spectrum antibiotic
- ✓ Vancomycin has Gram-positive activity only
- ✗ Oral vancomycin treats systemic Gram-positive infection
- ✓ Oral vancomycin is not absorbed; it treats *C. difficile* in the gut
- ✗ Vancomycin infusion reaction is IgE-mediated allergy
- ✓ It is rate-related histamine release, not IgE-mediated allergy
- ✗ Metronidazole has no significant warfarin interaction
- ✓ Metronidazole increases warfarin effect; INR may rise significantly

Penicillins

Class mechanism	Inhibit PBPs/transpeptidase, preventing peptidoglycan cross-linking; weakened wall leads to osmotic lysis.
Benzylpenicillin	IV/IM only; key emergency use is meningococcal disease; adult dose 1.2 g IV/IM.
Phenoxymethylpenicillin	Oral penicillin V; streptococcal throat infections and prophylaxis after splenectomy or rheumatic fever.
Flucloxacillin	Beta-lactamase-resistant; active against MSSA, not MRSA.
Amoxicillin	Broad aminopenicillin; respiratory infections, UTIs, otitis media and <i>Listeria</i> ; EBV rash is not usually true allergy.
Ampicillin	Similar to amoxicillin; less well absorbed orally; important for <i>Listeria</i> coverage in meningitis regimens.
Co-amoxiclav	Amoxicillin plus clavulanate; bites, polymicrobial infection, non-responding CAP and intra-abdominal infection; diarrhoea and cholestatic jaundice.
Allergy	True immediate allergy includes anaphylaxis, angioedema or urticaria; cephalosporins require caution because cross-reactivity can occur.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ All reported penicillin allergies are true IgE-mediated allergy
- ✓ Clarify history: true immediate allergy is anaphylaxis, angioedema or urticaria
- ✗ Flucloxacillin is appropriate for MRSA
- ✓ Flucloxacillin covers MSSA only; MRSA's altered PBP2a requires a non-beta-lactam MRSA-active option
- ✗ Benzylpenicillin can be given orally
- ✓ Benzylpenicillin is acid-labile, so IV/IM only; phenoxymethylpenicillin is the oral formulation
- ✗ Amoxicillin rash in EBV glandular fever indicates lifelong penicillin allergy
- ✓ The EBV amoxicillin rash is not usually true allergy
- ✗ Clavulanate in co-amoxiclav has no adverse effects of its own
- ✓ Clavulanate extends beta-lactamase cover but contributes to diarrhoea and cholestatic jaundice

Quinolones

Type drug	Ciprofloxacin
Mechanism	Inhibits DNA gyrase and topoisomerase IV

Killing pattern	Bactericidal; concentration-dependent
Spectrum emphasis	Broad; especially Gram-negative organisms including <i>Pseudomonas</i> and <i>Neisseria</i> ; some atypicals
Pyelonephritis dose	500 mg orally twice daily for 7 days
Gonorrhoea dose	500 mg orally as a single dose, only if the isolate is known to be susceptible
Major safety warning	Tendinitis and tendon rupture, especially Achilles tendon
High-risk groups for tendon injury	Older patients, concurrent corticosteroids, renal transplant patients
Important interactions	Antacids reduce absorption; ciprofloxacin increases theophylline levels via CYP1A2 inhibition

EXAM TRAPS × tempting option ✓ correct answer

- × Achilles pain on ciprofloxacin is a minor side-effect to monitor
- ✓ Tendon symptoms require immediate discontinuation (risk of tendon rupture)
- × Corticosteroids do not affect quinolone tendon rupture risk
- ✓ Concurrent corticosteroids increase quinolone tendon rupture risk
- × Ciprofloxacin is a routine first-line option for uncomplicated infection
- ✓ Not routine first line, due to modern restrictions and resistance concerns
- × Antacids and iron do not affect ciprofloxacin absorption
- ✓ Antacids, iron and mineral supplements reduce ciprofloxacin absorption
- × Ciprofloxacin has no clinically important theophylline interaction
- ✓ Ciprofloxacin inhibits CYP1A2, raising theophylline (narrow therapeutic index) to dangerous levels

Tetracyclines

Mechanism	30S ribosomal inhibition → prevents tRNA binding → bacteriostatic protein synthesis inhibition
Type drug	Doxycycline
Core uses	Chlamydia, <i>Mycoplasma</i> , <i>Rickettsia</i> , Lyme disease, <i>Brucella</i> , <i>Vibrio</i> , some MRSA, malaria prophylaxis
Avoid in	Children under 12 years, pregnancy, breastfeeding
Key adverse effects	Photosensitivity, oesophageal irritation, GI disturbance, teeth discolouration
Key interactions	Antacids, dairy products and iron reduce absorption

EXAM TRAPS × tempting option ✓ correct answer

- × Doxycycline is bactericidal
- ✓ Tetracyclines are generally bacteriostatic (30S inhibition)
- × Doxycycline absorption is unaffected by dairy products
- ✓ Antacids, dairy products and iron chelate tetracyclines and reduce absorption
- × Tetracyclines are safe in pregnancy and young children
- ✓ Avoid in pregnancy and under 12 years; deposition in developing teeth and bone
- × Doxycycline has no activity against atypical organisms
- ✓ Doxycycline is useful for atypicals such as *Chlamydia* and *Mycoplasma*

Urinary Tract Infections

Most common UTI organism	<i>E. coli</i> , approximately 70-80% of cases
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Other organisms	Klebsiella, Proteus, Enterococcus, Staphylococcus saprophyticus
Childhood UTI principle	Treat promptly to prevent ascending infection, pyelonephritis and renal scarring
Trimethoprim mechanism	Inhibits dihydrofolate reductase; impairs folate synthesis; bacteriostatic
Trimethoprim uses	Uncomplicated UTI and prophylaxis of recurrent UTI
Important adverse effects	GI disturbance, rash, bone marrow suppression, hyperkalaemia
Key cautions	Pregnancy, especially first trimester; severe renal impairment
Monitoring	Renal function; FBC with prolonged use

EXAM TRAPS × tempting option ✓ correct answer

- ✗ All UTIs are caused by E. coli
- ✓ E. coli causes most (70-80%); Klebsiella, Proteus, Enterococcus and S. saprophyticus also cause UTI
- ✗ Childhood UTI can be managed expectantly without urgency
- ✓ Treat early; ascending infection can cause pyelonephritis and renal scarring
- ✗ Trimethoprim has no electrolyte or marrow effects
- ✓ Trimethoprim can cause hyperkalaemia and marrow suppression, especially if prolonged or renal function reduced
- ✗ Trimethoprim is safe in the first trimester of pregnancy
- ✓ As a folate antagonist, it should generally be avoided in the first trimester

Antifungal Preparations

Candidiasis Management

Drug	Nystatin
Class	Polyene antifungal
Mechanism	Binds ergosterol; forms membrane pores; causes cell lysis
Absorption	Not absorbed from the gastrointestinal tract
Uses	Oral, gastrointestinal, vaginal, cutaneous, and mucosal candidiasis
Limitation	Not effective for systemic fungal infection
Side-effects	Minimal systemic effects; GI disturbance may occur with high doses

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oral nystatin treats systemic fungal infection
- ✓ Oral nystatin stays in the gut lumen and does not produce systemic antifungal levels
- ✗ Nystatin binds cholesterol in fungal membranes
- ✓ Nystatin binds ergosterol, not cholesterol

Antimalarials

Falciparum Malaria Management

Core ED principle	Fever after travel to a malaria-endemic region: exclude falciparum malaria urgently.
Unknown organism	Treat empirically as falciparum malaria.
Uncomplicated falciparum malaria	Oral therapy; Malarone (atovaquone-proguanil) is one option.

Severe/cerebral malaria	Parenteral therapy; IV artesunate is first line in the UK, with IV quinine as the alternative.
Quinine partner drug	Doxycycline or clindamycin.
Quinine toxicity	Cinchonism, QT prolongation, hypoglycaemia.
Pregnancy	Use effective therapy; quinine is acceptable with glucose monitoring. Avoid Malarone unless specialist advice; avoid mefloquine in first trimester.
Delayed presentation	Malaria may present up to one year after return; vivax/ovale may relapse years later.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Malaria is excluded if travel was several months ago
- ✓ Malaria may present up to one year after return; vivax/ovale may relapse years later
- ✗ Await full species identification before treating suspected malaria
- ✓ Treat a clinically concerning case empirically as falciparum malaria
- ✗ Malarone is suitable for severe or cerebral malaria
- ✓ Severe malaria needs parenteral therapy (IV artesunate first line); oral therapy is for uncomplicated disease
- ✗ Hypoglycaemia is not an adverse effect of quinine
- ✓ Quinine causes hypoglycaemia, particularly in pregnancy or severe malaria
- ✗ Falciparum malaria relapses from dormant liver hypnozoites
- ✓ Vivax and ovale relapse due to dormant liver hypnozoites; falciparum does not

Herpesvirus Infections

Herpes Simplex and Varicella-Zoster

HSV-1	Usually orofacial; can also cause keratoconjunctivitis and encephalitis.
HSV-2	Usually genital herpes; severe primary disease needs systemic therapy.
Local cold sore	Topical aciclovir cream, most effective at prodrome.
Ocular HSV	Topical aciclovir eye treatment plus careful ophthalmic assessment.
Systemic HSV indications	Encephalitis, immunocompromised host, severe primary genital herpes, neonatal HSV.
Neonatal varicella risk	Highest when maternal chickenpox occurs from 7 days before to 7 days after delivery.
Pregnancy varicella	Risk of maternal pneumonitis and foetal varicella syndrome; manage urgently and follow current UK guidance.
Shingles	Treat within 72 hours where indicated; urgent attention for ophthalmic zoster.
Aciclovir mechanism	Activated by viral thymidine kinase; inhibits viral DNA polymerase; causes chain termination.
Aciclovir cautions	Renal impairment and hydration are key, especially with IV therapy.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ HSV-1 infection is always benign
- ✓ HSV-1 can cause encephalitis and ocular disease (keratoconjunctivitis)
- ✗ Ophthalmic zoster is managed like simple shingles
- ✓ Eye involvement requires urgent treatment and specialist assessment
- ✗ Antivirals for shingles are equally beneficial whenever started

- ✓ Benefit is greatest when started within 72 hours of rash onset
- ✗ IV aciclovir needs no renal consideration
- ✓ IV aciclovir can cause crystalluria and nephrotoxicity; adjust dose and ensure hydration
- ✗ VZIG alone is standard for susceptible pregnant varicella contacts
- ✓ Current UK practice favours antiviral PEP; immunoglobulin is reserved for selected circumstances

PHARMACOLOGY · TOPIC 6 OF 10

Endocrine System

Corticosteroids (Endocrine)

Glucocorticoids

Prednisolone	Primarily glucocorticoid; some mineralocorticoid activity; oral use in maintenance therapy and chronic inflammatory disease.
Hydrocortisone	Balanced glucocorticoid and mineralocorticoid activity; IV/IM in acute adrenal insufficiency, anaphylaxis adjunct and severe asthma; oral for adrenal replacement.
Dexamethasone	Potent glucocorticoid with minimal mineralocorticoid effect; useful in cerebral oedema, meningitis adjunct, croup and high-dose anti-emetic use.
Mineralocorticoid effect	Sodium and water retention; potassium and hydrogen ion loss; can cause hypertension and hypokalaemia.
Glucocorticoid effect	Anti-inflammatory, immunosuppressive, metabolic and catabolic actions.
Choosing principle	Addison's physiology favours hydrocortisone; cerebral oedema favours dexamethasone.

⚠ **EXAM TRAPS** ✗ tempting option ✓ correct answer

- ✗ All corticosteroids are clinically equivalent
- ✓ Mineralocorticoid activity differs between steroids and is clinically important
- ✗ Dexamethasone is the drug of choice for adrenal replacement
- ✓ Hydrocortisone, because it has useful mineralocorticoid as well as glucocorticoid activity
- ✗ Hydrocortisone is preferred for cerebral oedema
- ✓ Dexamethasone: strong glucocorticoid action with minimal mineralocorticoid fluid retention

Implications of Corticosteroid Therapy

Main endocrine risk	HPA-axis suppression causing impaired endogenous cortisol response
Withdrawal risk	Acute adrenal insufficiency if stopped abruptly after prolonged therapy
Infection risk	Increased susceptibility and masked inflammatory signs
Viral exposure risk	Chickenpox, shingles and measles exposure need urgent assessment if immunity is uncertain
Steroid card purpose	Alerts clinicians to steroid dependence and need for stress-dose consideration
Safe prescribing principle	Use the lowest effective dose for the shortest necessary duration and taper prolonged therapy

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Steroid withdrawal is only a chronic outpatient issue
- ✓ Sudden cessation or missed doses may present to ED with hypotension, collapse or hypoglycaemia
- ✗ Absence of fever excludes significant infection in a patient on steroids
- ✓ Steroids mask fever and local inflammatory signs while infection progresses
- ✗ Chickenpox and measles pose no special risk on steroids
- ✓ Chickenpox and measles are specifically high-risk in immunosuppressed steroid-treated patients
- ✗ A steroid card is an administrative record only
- ✓ It is a safety tool identifying adrenal suppression risk and preventing abrupt withdrawal

Diabetes – Insulin

Insulin Preparations

Standard insulin for IV infusion	Short-acting soluble/regular insulin
Short-acting examples	Actrapid; Humulin S
Intermediate example	Isophane/NPH: Insulatard; Humulin I
Long-acting examples	Glargine; detemir
Type 1 regimen	Basal-bolus: basal insulin plus short-acting insulin with meals
Type 2 starting regimen	Often once-daily basal insulin; mixed twice-daily regimens may be used
Driving principle	Notify DVLA, check glucose before and during long journeys, avoid driving with low glucose, and observe stricter Group 2 rules

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Soluble insulin is a rapid-acting analogue
- ✓ Soluble/regular insulin is short-acting, with onset 30-60 minutes
- ✗ Any insulin preparation can be given IV
- ✓ Only soluble insulin is used IV; intermediate- and long-acting insulins must never be given IV
- ✗ Long-acting basal analogues cover meals
- ✓ Long-acting basal analogues (glargine, detemir) are not meal-covering insulins
- ✗ Insulin therapy has no driving implications
- ✓ Insulin requires DVLA notification and hypoglycaemia safety measures

Insulin in Diabetic Ketoacidosis (DKA)

Initial priority before insulin	IV fluid resuscitation
Insulin regimen	Fixed-rate IV insulin infusion
Dose	0.1 units/kg/hour
Main metabolic purpose	Suppress ketogenesis
Glucose effect	Lowers blood glucose
Potassium effect	Drives K ⁺ intracellularly; monitor and replace K ⁺

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Insulin in DKA is used only to lower glucose
- ✓ Its key early role is suppression of ketogenesis
- ✗ Start insulin in DKA regardless of potassium level
- ✓ If K⁺ is below 3.5 mmol/L, correct potassium first
- ✗ A normal or high initial potassium excludes potassium depletion in DKA
- ✓ Total body potassium may still be depleted; insulin drives K⁺ intracellularly
- ✗ DKA is treated with a variable sliding-scale insulin
- ✓ DKA requires a fixed-rate IV insulin infusion (0.1 units/kg/hour)

Diabetes – Oral Antidiabetics

Oral Hypoglycaemics Overview

Which oral hypoglycaemic class stimulates insulin secretion?	Sulphonylureas.
Which example represents sulphonylureas?	Gliclazide.
What is the major sulphonylurea risk?	Hypoglycaemia, especially in elderly patients and renal impairment.
Which example represents biguanides?	Metformin.
How does metformin lower glucose?	Reduces hepatic glucose output and improves peripheral insulin sensitivity.
Does metformin cause hypoglycaemia alone?	Usually no, because it does not directly stimulate insulin secretion.
What is the major serious metformin risk?	Lactic acidosis in renal failure, iodinated contrast exposure, or alcohol excess.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Metformin monotherapy commonly causes hypoglycaemia
- ✓ Sulphonylureas commonly cause hypoglycaemia; metformin alone usually does not
- ✗ Sulphonylurea hypoglycaemia resolves permanently after one glucose dose
- ✓ It may recur because the drug continues to stimulate endogenous insulin secretion
- ✗ Metformin is an insulin secretagogue
- ✓ Metformin reduces hepatic glucose output and improves insulin sensitivity
- ✗ Renal impairment does not affect oral hypoglycaemic safety
- ✓ Renal impairment increases sulphonylurea hypoglycaemia and metformin-associated lactic acidosis risk

Treatment of Hypoglycaemia

Glucagon

Specific drug	Glucagon
Main mechanism	Activates hepatic glucagon receptors → glycogenolysis → glucose release
Expected effect	Raises blood glucose by about 2-3 mmol/L within 10-15 minutes

Dose and route	1 mg IM or SC
Main use	Hypoglycaemia when oral glucose cannot be taken and IV access is unavailable
Reduced effect	Prolonged fasting, starvation, alcohol excess
After recovery	Give carbohydrate to replenish stores and prevent recurrence
Other role	High-dose use in beta-blocker/calcium-channel blocker overdose as a positive inotrope

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Glucagon works reliably in alcohol- or starvation-related hypoglycaemia
- ✓ Depleted glycogen stores make the glucagon response poor
- ✗ No further treatment is needed after recovery with glucagon
- ✓ Give carbohydrate after recovery; hypoglycaemia may recur as the transient effect wears off
- ✗ Give oral carbohydrate to an unconscious hypoglycaemic patient
- ✓ Unsafe due to aspiration risk; use parenteral treatment

Thyroid Disease

Thyroid Hormones and Antithyroid Drugs

Hypothyroidism	Thyroxine replacement with levothyroxine.
Thyrotoxic crisis (thyroid storm)	Antithyroid drugs, beta-blocker, supportive care and steroids.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Beta-blockade alone is sufficient treatment for thyroid storm
- ✓ Beta-blockers control symptoms but do not reduce hormone synthesis; antithyroid drugs are needed
- ✗ Steroids have no role in thyroid storm
- ✓ Steroids are part of standard thyroid storm management

PHARMACOLOGY · TOPIC 7 OF 10

Fluids and Electrolytes

Oral Preparations

Oral Potassium Supplements

- Potassium is crucial for membrane excitability, especially in cardiac muscle.
- Hypokalaemia is particularly dangerous in patients taking digoxin because it predisposes to digoxin toxicity.
- Nephrotic syndrome can indirectly lead to potassium loss because oedema is often treated with diuretics.
- Loop and thiazide diuretics promote potassium loss by increasing distal sodium delivery.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Nephrotic syndrome causes hypokalaemia through direct urinary potassium loss
- ✓ Indirectly: albumin loss causes oedema, treated with diuretics, which cause potassium loss

Oral Rehydration Therapy

Type example	Dioralyte
Core ingredients	Glucose, sodium chloride, potassium chloride, disodium hydrogen citrate
Main transporter	SGLT1 sodium-glucose co-transporter
Water movement	Follows sodium and glucose absorption osmotically
Main use	Mild to moderate dehydration from diarrhoea and vomiting
Advantage over water	Electrolyte replacement plus active sodium-water absorption

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Oral rehydration solution simply replaces water
- ✓ Its key principle is SGLT1 glucose-sodium co-transport driving water absorption
- ✗ Oral rehydration is ineffective in secretory diarrhoea
- ✓ SGLT1-mediated absorption can remain intact in secretory diarrhoea
- ✗ Plain water is equivalent to oral rehydration solution in diarrhoea
- ✓ Water does not replace electrolyte losses and may contribute to hyponatraemia

Parenteral Preparations

Intravenous Fluids

0.9% sodium chloride	Na ⁺ 154, Cl ⁻ 154; extracellular distribution; hyperchloraemic acidosis risk with large volumes.
Hartmann's solution	Na ⁺ 131; chloride 111; K ⁺ 5; Ca ²⁺ 2; lactate 29. Balanced crystalloid.
5% glucose	No Na ⁺ , Cl ⁻ or K ⁺ ; becomes free water after glucose metabolism; not a resuscitation fluid.
Potassium chloride mixtures	Give by infusion only; never bolus; usual maximum 10-20 mmol/hour with monitoring.
Sodium bicarbonate	8.4% = 1 mmol/mL Na ⁺ and HCO ₃ ⁻ ; severe acidosis, hyperkalaemia, TCA overdose.
Albumin	Colloid; intravascular expansion; selected use, especially liver disease/hypoalbuminaemia contexts.
Gelatin	Synthetic colloid; intravascular expansion; anaphylaxis, renal and coagulation cautions.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ 5% glucose remains intravascular because it is isotonic in the bag
- ✓ After glucose metabolism it behaves as free water; not a resuscitation fluid
- ✗ 0.9% saline has the same chloride concentration as plasma
- ✓ Saline contains 154 mmol/L chloride, more than plasma; large volumes cause hyperchloraemic acidosis
- ✗ Potassium chloride can be given as an IV bolus
- ✓ Never bolus; rapid IV potassium can cause cardiac arrest (usual max 10-20 mmol/hour)
- ✗ Colloids are always safer or better than crystalloids
- ✓ Albumin and gelatin have specific indications, costs and risks

Vitamin B Preparations

Thiamine (Vitamin B1)

Specific drug	Thiamine (vitamin B1), commonly as IV Pabrinex or equivalent injectable vitamin B preparation
Wernicke's encephalopathy	Acute deficiency state; confusion, ophthalmoplegia/nystagmus, ataxia; treat urgently
Korsakoff's syndrome	Chronic irreversible amnesic syndrome; anterograde and retrograde amnesia with confabulation
Glucose rule	Give thiamine before glucose in at-risk patients
Safety advice	IV preparations can cause anaphylaxis; resuscitation facilities must be available
Treatment dose	2 pairs IV TDS for 3-5 days, then 1 pair OD for maintenance
Prophylaxis dose	1 pair IV once daily for 3-5 days

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Thiamine should be given only when the full Wernicke triad is present
- ✓ The complete triad is often absent; treat suspected cases urgently
- ✗ Give glucose first in a malnourished alcohol-dependent patient
- ✓ Give thiamine before glucose in at-risk patients
- ✗ Korsakoff's syndrome is acute and readily reversible
- ✓ Wernicke's is acute and treatable; Korsakoff's is chronic and often irreversible
- ✗ Oral thiamine is sufficient for suspected Wernicke's encephalopathy
- ✓ IV thiamine (e.g. Pabrinex) is preferred for urgent reliable repletion

PHARMACOLOGY · TOPIC 8 OF 10

Musculoskeletal System

Corticosteroids (Musculoskeletal)

Local Corticosteroid Injections

Core mechanism	Glucocorticoid receptor activation reduces cytokines, prostaglandins, leukotrienes and inflammatory cell activity.
Main advantage	High local anti-inflammatory effect with less systemic exposure than systemic corticosteroids.
Main limitation	Symptom relief may be temporary and does not replace diagnosis or definitive disease control.
Do not miss	Avoid injection if infection is suspected; septic arthritis requires urgent assessment.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Local corticosteroid injections are risk-free
- ✓ Systemic and local complications can still occur
- ✗ Steroid injection is appropriate for a hot swollen joint
- ✓ Consider septic arthritis until proven otherwise; avoid injection if infection is suspected
- ✗ Repeated local steroid injections are harmless
- ✓ Cumulative effects include tendon weakening and skin or fat atrophy

Systemic Corticosteroids in Inflammatory Disease

Core action	Anti-inflammatory and immunosuppressive glucocorticoid effect
Main mechanism	Intracellular receptor binding with altered gene transcription
Rheumatoid arthritis role	Short-term bridging therapy while disease-modifying treatment provides long-term control
Temporal arteritis role	Urgent high-dose treatment to prevent visual loss

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Corticosteroids are long-term disease-modifying treatment in rheumatoid arthritis
- ✓ They are mainly short-term bridging therapy while DMARDs provide long-term control
- ✗ Await investigations before starting steroids in suspected temporal arteritis
- ✓ Start urgent high-dose steroids; visual loss may be irreversible

Drugs Used in Gout and Hyperuricaemia

Acute Gout Management

Clinical situation	Why NSAIDs are problematic	Why colchicine may be preferred
Heart failure	Fluid retention, renal impairment and worsening decompensation risk.	Anti-inflammatory effect without NSAID-mediated salt and water retention.
Concurrent anticoagulation	Higher bleeding risk, especially gastrointestinal bleeding.	No direct NSAID-like gastric mucosal or platelet effect, but check toxicity and interactions.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ An NSAID is first choice for acute gout in heart failure or on anticoagulants
- ✓ Colchicine may be safer: avoids NSAID fluid retention and bleeding risk
- ✗ Colchicine toxicity can be reversed with a specific antidote
- ✓ There is no specific antidote; prevention through careful prescribing is essential
- ✗ Colchicine has no significant drug interactions
- ✓ Colchicine interacts with macrolides, statins and ciclosporin

NSAIDs (NON-STEROIDAL ANTI-INFLAMMATORY DRUGS)

NSAID Overview and Mechanism

Main mechanism	COX inhibition leading to reduced prostaglandin synthesis
Therapeutic effects	Anti-inflammatory, analgesic and antipyretic

COX-1 role	Gastric mucosal protection, renal function and platelet aggregation
COX-2 role	Inflammation and pain; vascular prostacyclin production
GI harm	Reduced PGE2 causes reduced mucus and bicarbonate, leading to ulceration and bleeding
Coxib trade-off	Less GI toxicity but increased cardiovascular risk

EXAM TRAPS × tempting option ✓ correct answer

- × COX-2 selective NSAIDs are safe
- ✓ Coxibs reduce GI toxicity but increase cardiovascular risk
- × NSAIDs do not affect renal function
- ✓ Prostaglandins maintain renal perfusion; NSAIDs can worsen function when perfusion is compromised

Specific NSAIDs

Ibuprofen	Non-selective NSAID; lowest GI toxicity of standard NSAIDs; still causes class effects.
Naproxen	Longer half-life; twice-daily dosing; lower CV risk than some NSAIDs but intermediate GI toxicity.
Diclofenac	Useful analgesic with multiple routes; higher cardiovascular risk than ibuprofen and naproxen.
Mefenamic acid	Used mainly for dysmenorrhoea and menorrhagia; remember haematological toxicity.

EXAM TRAPS × tempting option ✓ correct answer

- × All NSAIDs have identical risk profiles
- ✓ Named NSAIDs differ in GI risk, cardiovascular risk, half-life and distinctive toxicities
- × Ibuprofen is harmless because it has the lowest GI toxicity
- ✓ Ibuprofen can still cause ulceration, renal impairment and bronchospasm
- × Mefenamic acid has no haematological adverse effects
- ✓ Mefenamic acid can cause Coombs-positive haemolytic anaemia, thrombocytopenia and rarely aplastic anaemia
- × Diclofenac has lower cardiovascular risk than ibuprofen and naproxen
- ✓ Diclofenac has higher cardiovascular risk than ibuprofen and naproxen

PHARMACOLOGY · TOPIC 9 OF 10

Immunological Products and Vaccines

Active Immunity

Post-Immunisation Pyrexia in Infants

Common cause	Expected immune response after vaccination
Vaccines especially associated with fever	Routine infant vaccines, particularly MenB when given with other vaccines
Main parental advice	Paracetamol when indicated, comfortable cooling, adequate fluids/feeds
Avoid	Aspirin under 16 years; excessive cooling; exceeding paracetamol dosing limits

Seek help if	Fever >38.5 °C, persistent fever, or any concerning clinical features
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⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Post-immunisation fever means vaccine failure or infection
- ✓ It is usually an expected immune response
- × Prophylactic antipyretics are routine at every vaccine appointment
- ✓ Current UK advice specifically emphasises MenB-containing infant appointments
- × Post-vaccine fever never needs further assessment
- ✓ Fever with abnormal behaviour, poor feeding or non-blanching rash needs urgent assessment

Side-Effects and Contra-Indications

Local side-effects	Redness, swelling and pain at injection site.
Systemic side-effects	Fever and malaise.
True general contra-indication	Anaphylaxis to previous dose or vaccine component.
Temporary deferral	Current febrile illness; vaccinate once recovered.
Live vaccine caution	Avoid in severe immunosuppression.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Fever is a permanent contra-indication to vaccination
- ✓ Current febrile illness means defer, then vaccinate after recovery
- × Fever and malaise after vaccination indicate allergy
- ✓ These are expected systemic effects; true contra-indication is anaphylaxis
- × Severe immunosuppression contra-indicates inactivated vaccines
- ✓ Severe immunosuppression is a caution chiefly for live vaccines

Types of Vaccines

Live attenuated	Weakened live organism; strong immunity; avoid in pregnancy and immunosuppression.
Inactivated	Killed organism or non-replicating component; safe in pregnancy/immunosuppression; often needs boosters.
Toxoid	Inactivated toxin; stimulates antitoxin antibody; tetanus and diphtheria are classic examples.
Core exam distinction	Live vaccines can replicate; inactivated and toxoid vaccines cannot.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All vaccines are unsafe in pregnancy
- ✓ Main concern is live attenuated vaccines; inactivated vaccines are generally safe when indicated
- × Toxoid vaccines directly target bacterial invasion
- ✓ Toxoids stimulate antitoxin antibody, protecting against toxin-mediated disease (e.g. tetanus, diphtheria)
- × Inactivated vaccines replicate like live attenuated vaccines
- ✓ Inactivated vaccines cannot replicate, so usually need booster doses

UK Immunisation Schedule

8 weeks	6-in-1 + MenB + Rotavirus
12 weeks	6-in-1 + MenB + Rotavirus
16 weeks	6-in-1 + PCV
1 year	PCV + MMRV + MenB
18 months	6-in-1 + MMRV in eligible cohorts
3 years 4 months	dTaP/IPV +/- MMRV according to cohort
12-13 years	HPV
14 years	Td/IPV + MenACWY
65 years	Pneumococcal vaccination; annual influenza from 65 years
75 years	RSV vaccine

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ The 2026 UK schedule gives MMR alone at key childhood points
- ✓ MMRV has replaced MMR-only framing at key childhood points in the 2026 schedule
- ✗ The 14-year booster is dTaP/IPV
- ✓ Td/IPV (with MenACWY) at 14 years; dTaP/IPV is the pre-school booster
- ✗ Pertussis is the only vaccine offered in pregnancy
- ✓ Influenza, pertussis and RSV vaccines are all offered in pregnancy
- ✗ Shingles vaccine is offered only to 70-year-olds
- ✓ Eligibility includes age-cohort changes and severely immunosuppressed adults over 18 years

Immunoglobulins

Anti-D Immunoglobulin

Product type	Passive immunoglobulin containing anti-D antibody
Recipient group	Non-sensitised RhD-negative pregnant women
Target	RhD-positive foetal red cells in maternal circulation
Purpose	Prevent maternal anti-D antibody formation
Future risk prevented	Haemolytic disease of the foetus and newborn
Routine prophylaxis	Usually at 28 weeks; some regimens also include 34 weeks
Post-delivery timing	Usually within 72 hours if the baby is RhD-positive

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anti-D immunoglobulin treats established RhD sensitisation
- ✓ It only prevents sensitisation; it cannot erase maternal immune memory once anti-D antibodies have formed
- ✗ Maternal anti-D antibodies cannot affect a later pregnancy
- ✓ Maternal anti-D IgG crosses the placenta and causes haemolysis in a later RhD-positive foetus
- ✗ Anti-D immunoglobulin generates long-term immunological memory
- ✓ Passive immunity: pre-formed antibody only; no immunological memory is generated
- ✗ Anti-D is only needed at delivery, not after minor antenatal events
- ✓ Also needed after sensitising events: antepartum bleeding, abdominal trauma, invasive antenatal procedures

Specific Immunoglobulins

HBIG	Needlestick or blood exposure from HBsAg-positive source; high-risk newborns of HBsAg-positive mothers; selected sexual exposures. Give with hepatitis B vaccine when indicated.
HTIG	Tetanus-prone wounds in patients with incomplete, uncertain, or inadequate protection. Give at a different site from tetanus vaccine.
VZIG	Selected susceptible high-risk contacts of varicella-zoster (e.g. neonates; others when antivirals are unsuitable). Oral antivirals are now first-line PEP for most, including pregnancy.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Immunoglobulin replaces the need for vaccination
- ✓ No: immunoglobulin is immediate but temporary; vaccine is slower but produces memory, so give both when indicated
- × Vaccine and immunoglobulin may be given at the same site
- ✓ Give at different sites when both are needed
- × HTIG neutralises toxin already bound to nerve tissue
- ✓ HTIG neutralises only unbound toxin, so delay reduces its benefit
- × Brief, distant contact counts as significant varicella exposure
- ✓ Significant exposure: close face-to-face contact or prolonged same-room exposure

Types of Immunoglobulin

What HNIG is	Pooled human plasma containing pre-formed antibodies.
Why it works quickly	It gives antibodies directly rather than waiting for active immune response.
Hepatitis A	Immediate protection for selected susceptible close contacts or travellers.
Measles	Protection/attenuation for non-immune high-risk contacts; remember the 6-day exposure window.
Cautions	IgA deficiency and theoretical blood product risks.
Side-effects	Local reactions; rarely anaphylaxis.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × HNIG works like a vaccine and creates immune memory
- ✓ HNIG gives immediate passive protection but creates no immune memory
- × HNIG for measles contacts is effective at any time after exposure
- ✓ Give within 6 days of measles exposure
- × Blood-derived immunoglobulin products carry no infection risk
- ✓ Screening makes risk very low, but a theoretical blood product risk remains
- × IgA deficiency is no concern with HNIG
- ✓ IgA deficiency is a caution: risk of severe hypersensitivity

Passive Immunity

Passive Immunity Principles

Core mechanism	Pre-formed antibodies are administered directly.
Main advantage	Immediate protection.

Main limitation	Temporary effect only.
Memory	No immunological memory is generated.
Main uses	Protection when vaccination would be too slow, post-exposure prophylaxis, and protection of immunocompromised patients.

EXAM TRAPS × tempting option ✓ correct answer

- × Passive immunity is immediate and long-lasting
- ✓ Passive immunity is immediate but short-lived
- × Passive immunoglobulin transfer generates immunological memory
- ✓ Memory is a feature of active immune responses only, not passive antibody transfer
- × Immunocompromised patients are protected adequately by active vaccination
- ✓ They may need passive antibody because vaccination may not produce an adequate response

Specific Vaccines and Preparations

Specific Vaccines

BCG	Live attenuated; prevents severe childhood TB; intradermal only.
Hib	Conjugate vaccine; protects against meningitis and epiglottitis.
Hepatitis A	Inactivated; travel and risk-group vaccine; two doses for full protection.
Hepatitis B	Recombinant surface antigen; routine infant component and occupational/exposure-risk vaccine.
MMR	Live attenuated; contraindicated in pregnancy/immunosuppression; egg allergy is not a contraindication.
MenB/MenACWY/MenC	Different preparations target different meningococcal groups and schedule points.
Pertussis	Acellular component; maternal vaccination protects the newborn.
Polio	IPV used in UK; OPV no longer routine because of VAPP risk.
Rabies	Wound cleaning + vaccine; add HRIG for selected high-risk exposures.
Tetanus	Toxoid vaccine; add immunoglobulin for tetanus-prone/high-risk wounds when indicated.

EXAM TRAPS × tempting option ✓ correct answer

- × Egg allergy contraindicates MMR vaccine
- ✓ Egg allergy is not a contraindication to MMR
- × BCG and MMR are safe in significant immunosuppression
- ✓ Both are live attenuated vaccines and must be avoided in significant immunosuppression
- × Rabies prophylaxis is pointless once time has passed since exposure
- ✓ Still risk-assess and treat: rabies incubation can be prolonged
- × Tetanus vaccine and immunoglobulin may share an injection site
- ✓ Give at different sites when both are required
- × Vaccine gives immediate protection like immunoglobulin
- ✓ Vaccine takes time to work; immunoglobulin provides immediate but temporary antibody protection

Anaesthesia

Antagonist Agents

Flumazenil

Drug class	Benzodiazepine antagonist
Mechanism	Competitive antagonist at the benzodiazepine site on GABA-A receptors
Effect	Reverses benzodiazepine-induced sedation and respiratory depression
Major contraindications	Benzodiazepine dependence, TCA overdose, benzodiazepines used for seizure control
Half-life issue	About 1 hour; shorter than many benzodiazepines
Main practical risk	Resedation and seizures/withdrawal in high-risk patients
Overdose principle	Not routine in polypharmacy overdose

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Flumazenil reverses sedation from any sedative drug
- ✓ Flumazenil is specific to benzodiazepines
- ✗ Flumazenil is appropriate in tricyclic antidepressant overdose
- ✓ Contraindicated: removes seizure suppression without treating dangerous cardiac toxicity
- ✗ A single flumazenil dose gives lasting reversal
- ✓ Resedation can occur: flumazenil (half-life about 1 hour) is shorter acting than many benzodiazepines
- ✗ Flumazenil is safe in benzodiazepine-dependent patients
- ✓ Contraindicated: may precipitate withdrawal and seizures

Naloxone

Class	Pure competitive opioid receptor antagonist
Receptors	Antagonises μ , κ and δ opioid receptors
Main use	Reversal of opioid-induced CNS and respiratory depression
Key target	Restore ventilation, not full consciousness
IV dose	0.4–2 mg IV, titrated and repeated as needed
Other routes	IM, SC and intranasal routes can be used when appropriate
Half-life	Short: approximately 60–90 minutes
Major risk after response	Re-narcotisation, especially after long-acting opioids
Major risk of over-reversal	Acute withdrawal, agitation, vomiting and sympathetic effects

EXAM TRAPS × tempting option ✓ correct answer

- ✗ The aim of naloxone is to fully wake the patient
- ✓ The aim is restoration of adequate respiration, not full consciousness
- ✗ Naloxone outlasts the opioid it reverses
- ✓ Naloxone (half-life 60–90 minutes) may wear off first, causing recurrent respiratory depression
- ✗ Large naloxone doses are safe in opioid-dependent patients
- ✓ Large doses can precipitate acute withdrawal; titrate
- ✗ Response to naloxone means observation is no longer needed
- ✓ Observation is still needed: re-narcotisation can occur, especially after long-acting opioids

Inhalational Agents

Nitrous Oxide

Class	Inorganic gas
Main ED preparation	Entonox: 50% nitrous oxide + 50% oxygen
Main ED role	Procedural analgesia without intended loss of consciousness
Onset/offset	Rapid onset and rapid recovery
Common side-effect	Nausea and vomiting
Classic contraindication	Pneumothorax
Other contraindications	Bowel obstruction, recent intraocular gas surgery, raised ICP, pneumocephalus, B12 deficiency with chronic exposure
Biochemical toxicity	Methionine synthase inhibition with prolonged exposure

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Entonox is a sedative induction agent
- ✓ Its emergency department role is mainly procedural analgesia without intended loss of consciousness
- ✗ Nitrous oxide is safe in suspected pneumothorax
- ✓ Contraindicated: it diffuses into the pleural gas space and can expand it
- ✗ Brief one-off Entonox use typically causes megaloblastic anaemia
- ✓ B12-related megaloblastic anaemia is mainly a prolonged or repeated exposure issue

Intravenous Induction Agents

Etomidate

Class	Imidazole induction agent
Mechanism	GABA-A receptor agonist/enhancer causing CNS depression
Induction profile	Rapid onset, short duration
Cardiovascular effect	Minimal depression; haemodynamically stable
Main ED relevance	RSI/induction when haemodynamic stability is desirable
No analgesia	Requires separate analgesic strategy
Signature adverse effect	Adrenal suppression via 11-beta-hydroxylase inhibition
Important caution	Adrenal insufficiency; controversial in septic shock

EXAM TRAPS × tempting option ✓ correct answer

- × Etomidate provides analgesia
- ✓ Etomidate has no analgesic effect; a separate analgesic strategy is required
- × Etomidate's major adverse effect is cardiovascular collapse
- ✓ Major adverse effect is adrenal suppression (11-beta-hydroxylase inhibition); it is haemodynamically stable
- × Etomidate is a straightforward choice in septic shock
- ✓ Controversial in septic shock because of adrenal suppression, despite haemodynamic stability
- × Etomidate causes more hypotension and apnoea than propofol
- ✓ Propofol is more likely to cause significant hypotension and apnoea

Ketamine

Class	Phencyclidine derivative
Main mechanism	Non-competitive NMDA receptor antagonist
Anaesthetic state	Dissociative anaesthesia with amnesia and analgesia
Analgesia	Provides clinically useful analgesia; unlike propofol, etomidate and thiopental
Respiratory effect	Relatively preserves respiratory drive and laryngeal reflexes, but airway competence remains essential
Cardiovascular effect	Sympathomimetic: increases heart rate, blood pressure and cardiac output
Airway effect	Bronchodilator; useful in severe asthma with bronchospasm
Recovery effect	Emergence phenomena: hallucinations, vivid dreams or delirium
Secretions	Increases salivation; antimuscarinic may be considered
Head injury nuance	Traditional caution in raised ICP; may be acceptable when intubated and ventilated if clinically appropriate

EXAM TRAPS × tempting option ✓ correct answer

- × Ketamine is a purely hypnotic induction agent without analgesia
- ✓ Ketamine provides analgesia as well as dissociative anaesthesia
- × Ketamine carries no airway risk because respiratory drive is preserved
- ✓ It remains an anaesthetic drug requiring airway-capable clinicians
- × Ketamine is haemodynamically neutral
- ✓ Sympathomimetic: commonly increases heart rate and blood pressure
- × Ketamine is absolutely contraindicated in all head injuries
- ✓ Traditionally avoided in raised ICP, but may be used in intubated, ventilated patients when clinically appropriate

Propofol

Class	Phenol derivative
Main mechanism	Potentiates GABA-A receptor activity; also inhibits NMDA receptors
Onset and recovery	Rapid, smooth onset with rapid recovery
Infusion suitability	Short context-sensitive half-life; useful for infusion/TIVA
Useful properties	Pleasant awakening and anti-emetic effect
Major acute risks	Hypotension and apnoea
Analgesia	No analgesic properties
Rare serious toxicity	Propofol infusion syndrome: metabolic acidosis, rhabdomyolysis, cardiac failure

EXAM TRAPS × tempting option ✓ correct answer

- × Propofol provides analgesia
- ✓ Propofol causes anaesthesia/sedation but has no analgesic properties
- × Propofol is haemodynamically neutral
- ✓ Causes significant hypotension through vasodilation and negative inotropy
- × Apnoea is rare after propofol induction
- ✓ Apnoea is common after induction; airway competence and monitoring are essential
- × Propofol infusion syndrome follows routine brief induction
- ✓ Linked to prolonged high-dose infusion

Thiopental Sodium (Thiopentone)

Drug name	Thiopental sodium / thiopentone
Class	Barbiturate
Mechanism	Enhances GABA-A activity; increases duration of chloride channel opening
Main effect	Rapid CNS depression and anaesthetic induction
Onset	Rapid, about 20-30 seconds
Short duration after bolus	Redistribution from brain to muscle and fat
Analgesia	None
Useful properties	Smooth induction; anticonvulsant; lowers cerebral metabolic rate and ICP
Key adverse effects	Hypotension, tachycardia, apnoea, laryngospasm, tissue necrosis
Contraindications	Porphyria; haemodynamic instability

EXAM TRAPS × tempting option ✓ correct answer

- × Thiopental provides analgesia
- ✓ None: it is a hypnotic induction agent, not an analgesic
- × Thiopental's short action after a bolus is due to rapid metabolism
- ✓ Mainly due to redistribution from brain to muscle and fat
- × Thiopental is safe in porphyria
- ✓ Absolute contraindication: barbiturates can precipitate an acute porphyric crisis
- × Thiopental extravasation causes only minor local irritation
- ✓ Extravasation or intra-arterial injection can cause severe necrosis because the solution is highly alkaline

Local Anaesthesia

Local Anaesthetic Overview

- Local anaesthetics reversibly block voltage-gated sodium channels and prevent propagation of action potentials.
- Pain and temperature fibres are blocked before larger touch, pressure and motor fibres.
- Acidic infected tissue reduces effectiveness by increasing ionisation and reducing membrane penetration.
- Systemic toxicity affects the CNS and cardiovascular system; early neurological symptoms may precede seizures or cardiac arrest.
- Severe LAST requires standard resuscitation plus 20% lipid emulsion; propofol is not an alternative lipid rescue treatment.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Local anaesthetic failure in infected tissue is due to poor technique
- ✓ Low pH increases ionisation, reducing membrane penetration
- ✗ Local anaesthetic toxicity presents first with cardiovascular collapse
- ✓ CNS toxicity commonly appears before cardiovascular collapse
- ✗ Propofol can substitute for lipid emulsion in local anaesthetic toxicity
- ✓ Use 20% lipid emulsion; propofol must not be used as a substitute

Specific Local Anaesthetics

Fastest key agent	Lidocaine: rapid onset, short-to-intermediate duration.
Longest key agent	Bupivacaine: prolonged block, useful for regional and wound analgesia.
Most cardiotoxic listed agent	Bupivacaine.
Preferred Bier block agent	Prilocaine.
Topical paediatric preparation	EMLA: lidocaine 2.5% plus prilocaine 2.5%, under occlusion for 60-90 minutes.
Prilocaine-specific toxicity	Methaemoglobinaemia, treated with methylene blue if clinically significant.
LAST rescue treatment	20% intravenous lipid emulsion plus ABC, seizure control and CPR if required.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Bupivacaine has a higher maximum dose than lidocaine
- ✓ Bupivacaine has the lower maximum dose and greater cardiotoxicity
- ✗ Bupivacaine is suitable for Bier block
- ✓ Unsafe because of cardiotoxicity if the tourniquet releases; prilocaine is preferred
- ✗ EMLA works if applied immediately before cannulation
- ✓ Needs 60-90 minutes under occlusion to be effective
- ✗ Seizures or cardiac arrest are the first signs of local anaesthetic toxicity
- ✓ Metallic taste, tinnitus and perioral tingling can precede seizures or cardiac arrest
- ✗ Methaemoglobinaemia is associated with bupivacaine
- ✓ Prilocaine causes methaemoglobinaemia, especially in high doses or topical mixtures; treat with methylene blue

Muscle Relaxants

Pharmacological Basis

Drug	Class	Key examinable points
Atracurium	Non-depolarising	Competitive nicotinic antagonist; intermediate duration; Hofmann elimination; useful in renal/hepatic failure; histamine release can cause hypotension, flushing and bronchospasm.

Drug	Class	Key examinable points
Suxamethonium	Depolarising	Fastest onset and shortest duration; RSI drug when rapid onset and short duration required; hydrolysed by plasma cholinesterase; hyperkalaemia risk; malignant hyperthermia risk; prolonged apnoea in pseudocholinesterase deficiency.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Neuromuscular blockers sedate the patient
- ✓ They cause paralysis without sedation
- × Suxamethonium can be reversed with neostigmine
- ✓ Only non-depolarising agents are reversed by neostigmine-based reversal; suxamethonium cannot
- × Suxamethonium is safe in burns and spinal cord injury
- ✓ Dangerous hyperkalaemia risk in burns, spinal cord injury, crush injury, denervation and prolonged immobility
- × Atracurium depends on renal or hepatic elimination
- ✓ Hofmann elimination is organ-independent; useful in renal/hepatic failure

Sedatives and Analgesics in Anaesthesia

Benzodiazepines in Anaesthesia

Class mechanism	Enhance GABA-A receptor activity, increasing chloride influx and neuronal hyperpolarisation.
Main anaesthetic effects	Anxiolysis, sedation, anterograde amnesia, anticonvulsant activity and muscle relaxation.
Analgesia	No meaningful analgesic effect; painful procedures require analgesia.
Duration order	Midazolam < temazepam < lorazepam < diazepam.
Diazepam	Longest acting; active metabolites; oral, slow IV and rectal routes.
Temazepam	Short-acting; oral pre-operative anxiolysis/night sedation.
Lorazepam	Intermediate duration; no active metabolites; reliable IM absorption; IV/IM/sublingual routes.
Midazolam	Short-acting; water-soluble; IV/IM/buccal/intranasal; buccal route useful for paediatric emergency seizures.
Key risk	Respiratory depression, especially with opioids, alcohol or other CNS depressants.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Benzodiazepines provide analgesia
- ✓ They provide sedation, anxiolysis, amnesia and anticonvulsant effect, not analgesia
- × Diazepam is the shortest-acting benzodiazepine
- ✓ Midazolam is shortest acting; diazepam is longest acting
- × Diazepam has reliable intramuscular absorption
- ✓ Lorazepam has reliable IM absorption; diazepam does not
- × Benzodiazepines with opioids carry little added respiratory risk
- ✓ Combination with opioids or other sedatives markedly increases respiratory depression
- × Long-term benzodiazepines can be stopped abruptly

- ✓ Withdrawal can include seizures; gradual reduction is required

NOW TEST IT

Reading Pharmacology is not the same as answering it under time pressure.

Doses, antidotes and contraindications are where candidates drop easy marks. Drill them in MCQs with confidence rating, so you know which answers were knowledge and which were luck.

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CHAPTER 4

Microbiology

6 curriculum topics · 94 subtopics · 218 exam traps

Mechanisms of Disease · Natural and Innate Immunity · Controlling Infection · Principles of Investigation · Principles of Immunisation · Specific Pathogen Groups

MICROBIOLOGY · TOPIC 1 OF 6

Mechanisms of Disease

Basic Terminology

Key Definitions

What is colonisation?	A normal, non-pathological state in which microbes are present without causing disease.
What is a pathogen?	An organism capable of causing infection.
What is infection?	A microbe-induced state of disease.
What is the common interpretive error?	Assuming that every positive culture or swab automatically means infection.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Colonisation is synonymous with infection
- ✓ Colonisation is a non-pathological state; infection is microbe-induced disease
- × Identifying a pathogen proves active disease
- ✓ A pathogen is capable of causing infection; clinical context determines whether infection is present
- × Any positive culture indicates infection regardless of specimen site
- ✓ Interpretation depends on whether the specimen came from a normally sterile site or a colonised surface

Types of Pathogens

Term	Exam meaning	Example
Obligate pathogen	Always expected to cause disease when infection occurs	HIV
Conditional pathogen	Causes disease under certain conditions	Staphylococcus aureus
Opportunistic pathogen	Causes disease mainly in compromised hosts	Pneumocystis spp.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Presence of a microbe always means infection
- ✓ Significance depends on pathogen category, immune status and site; colonisation is normal at non-sterile sites

Mechanisms of Attachment, Invasion and Persistence

Attachment Strategies

Influenza	Haemagglutinin-mediated attachment
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Giardia lamblia	Specialised sucking disc attaches to gut mucosa
Plasmodium falciparum	Parasite-induced red cell protein expression promotes adhesion and cerebral malaria
HIV	Strong CD4 antigen binding

EXAM TRAPS × tempting option ✓ correct answer

- × Attachment, colonisation and invasion are identical terms
- ✓ Attachment is the binding step that may precede invasion or disease
- × *P. falciparum* severity is due to attachment to gut or respiratory mucosa
- ✓ Severity reflects infected red cells adhering in the microvasculature (parasite-induced red cell proteins)

Survival and Persistence Beyond Natural Barriers

Neisseria meningitidis	IgA protease supports mucosal persistence
Staphylococcus aureus	Protein A inhibits immune clearance via antibody/complement effects
Streptococcus pneumoniae	Capsule inhibits neutrophil action
Vibrio cholerae	Flagellated motility enhances virulence

EXAM TRAPS × tempting option ✓ correct answer

- × *Vibrio cholerae* motility causes the secretory diarrhoea
- ✓ Motility aids colonisation; cholera toxin causes the secretory diarrhoea
- × Bacterial capsules are passive structures
- ✓ Pneumococcal capsule is a key anti-phagocytic survival factor, inhibiting neutrophil action
- × Protein A is a virulence factor of *Streptococcus pneumoniae*
- ✓ Protein A belongs to *Staphylococcus aureus*; pneumococcus relies on its capsule

Toxin Production

Core mechanism	Microbial toxins alter host cell or tissue function
Cholera toxin	Causes watery secretory diarrhoea through altered intestinal epithelial transport
Tetanus toxin	Disrupts inhibitory neurological signalling

EXAM TRAPS × tempting option ✓ correct answer

- × Cholera diarrhoea is mainly due to bowel invasion
- ✓ Toxin-mediated secretory fluid loss through altered epithelial transport
- × Tetanus disease results from widespread bacterial spread
- ✓ Toxin-mediated disruption of inhibitory neurological signalling

MICROBIOLOGY · TOPIC 2 OF 6

Natural and Innate Immunity

Barriers to Infection

Enhanced Infection Risk from Skin Disorders

Core principle	Barrier compromise allows easier microbial colonisation and invasion.
Highest-risk example	Burns: significantly elevated infection risk.
Inflammatory examples	Eczema and psoriasis: elevated infection risk because the barrier is disrupted.
Exam distinction	The skin disorder itself is not necessarily infective; the breached barrier creates susceptibility.

 EXAM TRAPS × tempting option ✓ correct answer

- × Eczema and psoriasis are infectious skin disorders
- ✓ They are inflammatory; increased infection risk comes from barrier disruption
- × Burns carry little infection risk
- ✓ Burns remove the intact skin barrier, significantly elevating infection risk

Gastric Acid

Barrier type	Chemical innate barrier
Main mechanism	Low gastric pH due to hydrochloric acid
Target exposure	Pathogens swallowed with food, water, and saliva
Main effect	Reduces survival of ingested organisms before they reach the intestine

Mucociliary Clearance

Main mechanism	Mucus traps material; cilia move it upwards.
Protected site	Lower respiratory tract.
Normal effect	Helps maintain effective sterility.
If impaired	Retained secretions and increased infection risk.

 EXAM TRAPS × tempting option ✓ correct answer

- × The lower respiratory tract is sterile because organisms never enter it
- ✓ Organisms are inhaled but normally trapped by mucus and cleared by cilia
- × Impaired mucociliary clearance does not affect infection risk
- ✓ It allows retained secretions and microbes to persist, increasing infection risk

Secreted Antibacterial Compounds

Defence category	Secreted antibacterial compound
Type example	Lysozyme
Example site	Tears
Core function	Chemical antibacterial defence at an exposed surface

EXAM TRAPS × tempting option ✓ correct answer

- × Barriers to infection are only physical structures
- ✓ Secreted substances such as lysozyme in tears are also innate barriers

Skin as a Barrier

Physical barrier	Continuity of intact skin prevents microbial entry.
Chemical barrier	Sebum and inhibitory fatty acids suppress microbial survival on the surface.
Clinical risk	Breaches in skin integrity allow organisms or infected fluids to bypass normal defence.
Blood-borne virus examples	HIV and hepatitis B can be transmitted via breached skin exposure.

EXAM TRAPS × tempting option ✓ correct answer

- × HIV and hepatitis B can be transmitted through intact skin
- ✓ Intact skin is a barrier; transmission risk arises when skin is breached
- × The skin is only a physical barrier
- ✓ It is also chemical: sebum and inhibitory fatty acids suppress microbes

Urinary Tract Defence

Main defence	Flushing action of urine flow
Normal effect	Helps maintain effective sterility of the urinary tract
Mechanism	Dilution and physical removal of organisms
Risk when impaired	Stasis permits persistence, colonisation, and infection risk

Normal Bacterial Flora

Protective Role of Normal Flora

Normal flora	Resident microbes living on body surfaces without causing disease
Main protective mechanism	Competition for pathogen colonisation sites
Additional protective mechanism	Bacteriocin secretion by resident bacteria
Bacteriocins	Antimicrobial bacterial products that suppress competing organisms

Risks of Antibiotic Use on Flora

Normal state	Flora provide colonisation resistance.
Effect of antibiotics	Protective flora may be suppressed.
Clinical consequence	Pathogens may colonise or overgrow more easily.
Type example	Clostridioides difficile infection after antibiotic-associated flora suppression.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Normal flora are merely passive contamination
- ✓ They actively protect through competition for colonisation sites and bacteriocins
- × Antibiotics directly cause *C. difficile* colitis
- ✓ Antibiotics suppress protective gut flora, allowing *C. difficile* overgrowth and toxin-mediated disease

Phagocytes and Complement

Complement System

System type	Plasma protein system of innate immunity
Key terminal effect	Generation of a membrane attack complex
Main concept	Membrane damage and microbial killing
Deficiency association	Susceptibility to <i>Neisseria meningitidis</i> and <i>Streptococcus pneumoniae</i>

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Complement deficiency predisposes only to meningococcal infection
- ✓ Also predisposes to *Streptococcus pneumoniae* infection
- × Complement is purely inflammatory
- ✓ It also kills microbes directly via the membrane attack complex

Effects of Splenectomy

Normal spleen role	Blood filtration and macrophage-mediated phagocytosis
Effect of splenectomy	Loss of a key macrophage-rich clearance site
Main infection issue	Increased susceptibility to severe invasive infection
Organism group to recognise	Encapsulated bacteria, especially pneumococcus, meningococcus and Hib

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Splenectomy removes all macrophage function
- ✓ It removes the splenic component of macrophage-rich blood filtration only
- × Splenectomy matters only anatomically
- ✓ Key issue is impaired clearance of blood-borne microbes and risk of severe invasive infection
- × Splenectomy mainly predisposes to viral infection
- ✓ Encapsulated bacteria: pneumococcus, meningococcus and Hib

Phagocytic Cells

Phagocytosis	Cellular ingestion and destruction of microbes
Neutrophils	Rapid-response phagocytes involved in early infection control
Macrophages	Tissue phagocytes that ingest pathogens and debris
Opsonins	Microbe-coating molecules that enhance phagocytic activity

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Neutrophils and macrophages produce antibody
- ✓ They ingest pathogens; B cells produce antibody

MICROBIOLOGY · TOPIC 3 OF 6

Controlling Infection

Control of Hospital-Acquired Infection

Disinfection

Definition	Reduction in the number of infectious particles
Disinfectants	Substances that kill or inhibit microbes
Iodine	Slow-acting skin antibacterial disinfectant
Chlorhexidine	Anti-staphylococcal agent
Main exam distinction	Disinfection reduces microbial burden; sterilisation inactivates all infectious agents

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Chlorhexidine is slow acting; iodine is anti-staphylococcal
- ✓ Iodine is slow acting; chlorhexidine is particularly anti-staphylococcal

Hand Hygiene

Core purpose	Interrupt transmission of microorganisms in the healthcare environment
Essential mechanism	Mechanical removal using water, soap and friction
Must-clean areas	Palms, backs of hands, between fingers, backs of fingers, thumbs and fingertips

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Alcohol gel is always sufficient for hand hygiene
- ✓ Soap and water needed when hands are visibly soiled or with spore-formers such as *C. difficile*
- × Palms are the area most often missed in hand hygiene
- ✓ Thumbs and fingertips are commonly missed
- × Wearing gloves replaces hand hygiene
- ✓ Gloves reduce contact contamination but hands must still be cleaned

Patient Isolation

Main purpose	Prevent spread of infectious organisms from an isolated patient
Protective barriers	Aprons and gloves
Hand hygiene facilities	Designated sink and alcohol gel
Important principle	Gloves reduce contamination but do not remove the need for hand hygiene

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Gloves are a substitute for hand hygiene in isolation
- ✓ Hand decontamination is still required after glove removal and between patient contacts

Sterilisation

Feature	Autoclaving	Irradiation
Basic principle	Steam under pressure.	Radiation energy.
Main effect	Inactivates infectious agents through heat and moisture effects.	Damages microbial genetic material and prevents replication.
Typical use	Reusable items and materials that tolerate steam and heat.	Heat-sensitive or packaged disposable medical materials.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Disinfection and sterilisation are interchangeable terms
- ✓ Disinfection reduces infectious particle numbers; sterilisation inactivates all infectious agents

Endogenous and Exogenous Infection Sources

Endogenous Infection

Definition	Invasion by normal flora under particular conditions
Core mechanism	Barrier breach, impaired host defence, or movement into an inappropriate site
Aspiration pneumonia	Own upper airway/oral flora enter the lower respiratory tract
Neutropenic sepsis	Own flora invade when neutrophil defence is reduced
Cannulation	Own skin flora gain access through a device-related breach

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Normal flora always equals infection
- ✓ Flora are protective or harmless until they invade or enter the wrong site
- × Severe infection such as neutropenic sepsis must be exogenous
- ✓ Neutropenic sepsis can arise from the patient's own flora (endogenous)
- × Cannula-related infection always comes from external organisms
- ✓ Often endogenous: organisms from the patient's own skin flora

Exogenous Infection

Definition	Organisms acquired from a non-host, external origin
Legionella	Warm water systems; air conditioning
Clostridium	Soil; contaminated wounds
Salmonella	Contaminated food or water

Hospital-Acquired Infection

Definition

Definition	Infection not present or incubating at hospital admission
Core timing point	Assessment is anchored to the time of admission
Common confusion	An infection diagnosed after admission may still have been incubating beforehand

EXAM TRAPS × tempting option ✓ correct answer

- × Any infection detected after admission is hospital-acquired
- ✓ Not if it was already incubating on admission

Environmental Predispositions

Environmental factor	Why it predisposes to infection	Key example or circumstance
Air conditioning and piped air supplies	May disseminate contaminated aerosols or organisms through shared air-handling systems	Legionella
Water supplies	Warm or lukewarm pipework can support environmental persistence and multiplication	Legionella in lukewarm pipework
Fomites	Contaminated objects can transfer organisms between people or clinical areas	Vases, fans, viewing boxes
Hospital food	Poor temperature control or ward transport failures can allow contamination or bacterial growth	Food temperature control and transport to ward

EXAM TRAPS × tempting option ✓ correct answer

- × Legionella spreads mainly person to person
- ✓ Acquired from environmental water or aerosols (warm water systems, air conditioning)
- × Fomites are living carriers of infection
- ✓ Fomites are inanimate contaminated objects
- × Hospital food is not an infection risk
- ✓ Failures of temperature control and ward transport allow contamination or bacterial growth

Patient-Centred Predispositions

Patient-centred factor	How it increases infection risk	Core exam point
Restricted access to washing facilities	Reduces personal hygiene and allows organisms to persist on hands, skin, clothing, bedding, or nearby surfaces	Limited washing access is a practical infection risk in hospitalised or dependent patients
Disease or treatment lowering immune resistance	Weakens normal host defence, so colonisation or exposure is more likely to progress to infection	Susceptible patients may develop infection after lower levels of exposure
Close patient contact in a busy ED	Increases opportunities for direct contact, short-range respiratory spread, and transfer via shared surfaces	Crowding and proximity increase transmission opportunities before infection is recognised

EXAM TRAPS × tempting option ✓ correct answer

- × Hospital-acquired infection risk is purely environmental
- ✓ Patient susceptibility and behaviour are central to risk
- × Restricted access to washing facilities is not an infection risk
- ✓ Limited washing access lets organisms persist on hands, skin, clothing and bedding
- × ED crowding is only an operational issue
- ✓ Close patient contact increases opportunities for microbial transmission

Peripheral Cannulas

Core risk	Hospital-acquired bacteraemia
Mechanism	Skin breach plus indwelling intravascular device
Time effect	Risk increases directly with time in situ
Replacement rule	Review daily; remove when no longer needed or replace when clinically indicated (no routine 48-hour change)
Key organisms	Staphylococcus aureus; Staphylococcus epidermidis

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Peripheral cannulas are too small to cause bacteraemia
- ✓ They are a source of hospital-acquired bacteraemia (*S. aureus*, *S. epidermidis*); risk rises with time in situ

Staff Clothing and Hygiene

Required approach	Bare below the elbows.
Reason	It enables more effective hand, wrist and forearm hygiene.

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Bare below the elbows is merely a dress-code rule
- ✓ It is an infection-control measure enabling effective hand, wrist and forearm hygiene
- × Only visibly soiled clothing poses an infection risk
- ✓ Key issue is microbial transfer and incomplete hygiene, not merely dirty clothing
- × Wrist and forearm hygiene is irrelevant to infection control
- ✓ It matters when staff have close contact with patients; hence bare below the elbows

Urinary Catheters

Urinary stasis	Reduced flushing allows organisms to remain in place and multiply.
Catheter surface	A foreign surface that supports microbial adherence and colonisation.
Colonised catheter or urine	May precede symptomatic catheter-associated urinary tract infection.

⚠ **EXAM TRAPS** × tempting option ✓ correct answer

- × Catheter infection is mainly due to external contamination
- ✓ Catheterisation causes stasis and colonisation, weakening the urinary flushing defence

How Infection Spreads

Routes of Transmission

Droplet spread	Influenza; Neisseria meningitidis
Faecal–oral spread	Salmonella
Intact skin invasion	Leptospira
Breached skin invasion	Staphylococcus epidermidis
Sexual intercourse	HIV; Neisseria gonorrhoeae

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Leptospira requires breached skin to invade
- ✓ Leptospira invades intact skin; Staphylococcus epidermidis needs breached skin
- × Salmonella spreads by respiratory droplets
- ✓ Salmonella is faecal-oral; influenza and meningococcus spread by droplets

MICROBIOLOGY · TOPIC 4 OF 6

Principles of Investigation

Specimen Culture

Purpose and Methods of Culture

Main purpose of culture	Amplifies organism quantity to allow reliable detection
Liquid culture	Growth supported in a nutrient fluid medium
Solid culture	Growth supported on a firm nutrient surface
Core limitation	Culture depends on viable organisms being present and appropriate conditions for growth

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Culture examines the specimen directly without growth
- ✓ Culture first amplifies organisms; microscopy examines the specimen directly

Specimen Examination

Microscopy Techniques

Stool parasites	Light microscopy
Nasopharyngeal aspirate RSV detection	Immunofluorescence microscopy
CSF bacteria	Direct Gram stain
Sputum tuberculosis	Ziehl-Neelsen stain
Malaria blood films	Giemsa stain

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Tuberculosis in sputum is identified with a Gram stain
- ✓ Requires acid-fast Ziehl-Neelsen stain
- × Malaria is diagnosed with a Gram-stained blood film
- ✓ Giemsa-stained blood films

Molecular Techniques

Main method	Nucleic acid amplification techniques, especially PCR
What is detected	Microbial DNA or RNA target sequences
Main advantage	Useful when organisms are slow-growing or difficult to culture rapidly

Type examples	Mycobacterium tuberculosis and Chlamydia trachomatis
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⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Culture always gives rapid results
- ✓ Mycobacteria grow slowly, so tuberculosis culture is slow
- × PCR detects the host antibody response
- ✓ PCR/NAAT detects microbial nucleic acid; serology detects host response
- × Typical NAAT targets are rapidly growing organisms like E. coli
- ✓ Classic NAAT targets: Mycobacterium tuberculosis and Chlamydia trachomatis

Serology

Basic process	Pathogen identified via the immune response it raises
Usual diagnostic basis	Rising or falling antibody levels in serial specimens
Reason serial samples matter	They show the direction of immune response over time
Alternative approach	Detection of a specific microbial antigen
Type example	Bacterial capsular antigens in CSF

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A single antibody result is diagnostic of current infection
- ✓ Diagnosis usually needs rising or falling titres in serial specimens
- × Antigen tests detect the host immune response
- ✓ Antigen tests detect a microbial component; antibody tests detect the host response

Specimen Types

Specimen Selection by Condition

UTI	Midstream specimen of urine
Skin wound	Wound swab
Meningitis	CSF + blood culture
Non-specific pyrexia	Blood culture + serology
Pneumonia	Blood + sputum

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × CSF alone is sufficient in suspected meningitis
- ✓ Send CSF plus blood culture
- × Non-specific pyrexia is investigated with a local specimen
- ✓ Blood culture plus serology unless a localising source is present
- × Sputum alone is sufficient in pneumonia
- ✓ Send blood cultures as well as sputum
- × MSU and MSSU are different urine specimens
- ✓ Both refer to a midstream urine specimen, used for UTI

MICROBIOLOGY · TOPIC 5 OF 6

Principles of Immunisation

Additional Immunisation Schedules

Vaccines for Healthcare Workers and Exposed Patients

Healthcare worker with blood exposure risk	Hepatitis B vaccination through occupational health, with attention to antibody response where relevant.
Needlestick or similar accidental exposure	Urgent risk assessment; hepatitis B vaccine booster/course and/or hepatitis B immunoglobulin may be needed depending on immunity and source risk.
Dirty or devitalised wound	Assess tetanus immunisation status; give reinforcing vaccine and/or tetanus immunoglobulin when indicated.
Healthcare worker during flu season	Annual influenza vaccination reduces staff illness and patient transmission risk.
At-risk patient during flu season	Annual influenza vaccination reduces risk of severe influenza-related illness.

 EXAM TRAPS × tempting option ✓ correct answer

- × Wound cleaning alone manages tetanus risk
- ✓ Immunisation status and wound type determine need for vaccine and/or immunoglobulin
- × Influenza vaccine is a single lifelong course
- ✓ Seasonal; repeated annually for eligible groups

Normal Childhood Immunisation Schedule

Standard UK Childhood Vaccines

DPT	Given through combined vaccines in infancy, with later boosters.
Hib	Included in the infant 6-in-1 vaccine; protection is aimed at invasive Hib disease.
Polio	Given as inactivated polio vaccine within injectable combination vaccines.
MMR	Now represented in routine childhood scheduling as part of MMRV.
Varicella	Included in the current routine childhood programme through MMRV.

 EXAM TRAPS × tempting option ✓ correct answer

- × The UK childhood schedule uses oral polio vaccine
- ✓ Inactivated polio vaccine within injectable combination vaccines
- × Varicella is absent from the UK routine childhood schedule
- ✓ Now included through MMRV
- × The teenage Td/IPV booster includes pertussis
- ✓ Pertussis is in the pre-school dTaP/IPV booster, not Td/IPV

MICROBIOLOGY · TOPIC 6 OF 6

Specific Pathogen Groups

Chlamydia

Chlamydia trachomatis (Primary Focus)

Primary species	Chlamydia trachomatis
Neonatal eye disease	Conjunctivitis with eyelid swelling, conjunctival injection and watery or mucopurulent discharge
Key neonatal complication	Subsequent pneumonitis due to respiratory tract involvement
Genital infection	Frequently asymptomatic; may cause cervicitis, urethritis, pelvic pain or epididymal symptoms
Treatment principle	Systemic antibiotic therapy; partner management for genital infection; systemic therapy for neonatal disease

 EXAM TRAPS × tempting option ✓ correct answer

- × Neonatal chlamydial conjunctivitis is only an eye problem
- ✓ Risk of subsequent pneumonitis is central
- × Absence of symptoms excludes genital chlamydia
- ✓ Genital chlamydia is frequently asymptomatic
- × Topical therapy alone treats neonatal chlamydial ophthalmia
- ✓ Systemic antibiotics needed because of systemic and respiratory involvement

Other Chlamydial Species

Main additional species	C. psittaci and C. pneumoniae
Key disease association	Atypical pneumonia; psittacosis can be severe

 EXAM TRAPS × tempting option ✓ correct answer

- × All chlamydial disease is due to C. trachomatis
- ✓ C. psittaci and C. pneumoniae cause atypical pneumonia

Clostridial Infection

Clostridial Colitis (Clostridioides difficile)

Normal location	Large bowel; colonisation may be asymptomatic.
Trigger	Antibiotic suppression of normal flora.
Pathogenesis	Toxin-mediated colonic epithelial injury and inflammation.
Clinical features	Watery diarrhoea, abdominal pain, fever, raised WCC; severe cases may develop pseudomembranous colitis or toxic megacolon.
Isolation	Single room/contact precautions, gloves and aprons, soap-and-water hand hygiene, sporicidal cleaning.
Drug therapy principle	Stop unnecessary antibiotics; use targeted anti-C. difficile treatment, with oral vancomycin as current first-line adult therapy.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ *C. difficile* colonisation equals infection
- ✓ Symptomatic toxin-mediated colitis is the clinically important state; colonisation may be asymptomatic
- ✗ Alcohol gel is adequate for *C. difficile* hand hygiene
- ✓ Spores require soap-and-water hand hygiene and sporicidal cleaning
- ✗ All antibiotic-associated diarrhoea is *C. difficile*
- ✓ Not all, but recent antibiotics plus new diarrhoea should prompt consideration

Clostridial Gas Gangrene (*Clostridium perfringens*)

Organism	<i>Clostridium perfringens</i> , an anaerobic spore-forming bacillus.
Predisposing wound	Crushed, ischaemic, contaminated or devitalised tissue with low oxygen tension.
Pathogenesis	Spore germination, toxin production, vascular injury, muscle necrosis and gas production.
Clinical pattern	Rapidly progressive severe wound pain, swelling, skin discolouration, crepitus and systemic toxicity.
Treatment principle	Urgent surgical debridement/source control plus intravenous antibiotics and supportive care.
Prevention principle	Clean contaminated wounds early and remove devitalised tissue before anaerobic infection becomes established.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Gas gangrene can be managed as a routine wound infection with antibiotics
- ✓ Urgent surgical debridement/source control is essential, plus IV antibiotics and supportive care
- ✗ Escalation for gas gangrene should await visible gas or crepitus
- ✓ Escalate on the clinical picture of clostridial myonecrosis; gas/crepitus need not be present first
- ✗ Gas gangrene is a neurotoxin-mediated disease caused by *C. tetani*
- ✓ Gas gangrene is myonecrosis from *C. perfringens*; tetanus is neurotoxin-mediated disease from *C. tetani*

Tetanus (*Clostridium tetani*)

Organism	<i>Clostridium tetani</i> , an anaerobic spore-forming Gram-positive bacillus.
Risk tissue	Dirty, contaminated, crushed, burnt, or devitalised tissue can harbour spores and support anaerobic germination.
Main toxin	Tetanospasmin disrupts inhibitory neurological signalling.
Clinical pattern	Trismus, rigidity, painful spasms, dysphagia, autonomic instability, and possible respiratory compromise.
Treatment principles	Immunoglobulin, wound debridement, antibiotics, spasm control, organ support, and active immunisation.
Prevention	Good wound care, assessment of immunisation status, vaccine boosters where indicated, and immunoglobulin for selected high-risk wounds.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Previous tetanus infection gives reliable lifelong immunity
- ✓ Natural infection does not give reliable immunity; vaccinate according to immunisation status
- ✗ A small wound cannot be tetanus-prone
- ✓ Any wound can be tetanus-prone if contaminated, deep, devitalised or containing foreign material, regardless of size

Gastrointestinal Viruses

Norovirus

Transmission	Faecal-oral spread, contact spread, fomites, contaminated food/water and aerosolised vomit particles
Hospital relevance	Rapid outbreaks requiring isolation, enhanced cleaning and infection-control input
Pathology	Small bowel epithelial infection
Clinical pattern	Acute vomiting and watery diarrhoea, often with abdominal cramps
Diagnosis	Often clinical in single cases; laboratory confirmation is important in outbreaks and public health management

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Norovirus is mainly a respiratory virus because vomiting aerosolises particles
- ✓ Norovirus is a gastrointestinal virus, spread faecal-orally and partly via environmental contamination including aerosolised vomit
- ✗ Alcohol hand gel alone is adequate for norovirus outbreak control
- ✓ Soap-and-water hand hygiene and environmental cleaning are central to norovirus outbreak control
- ✗ Uncomplicated norovirus should be treated with antibiotics
- ✓ Management is supportive with infection control; antibiotics have no role

Rotavirus

Main patient group	Infants and young children
Seasonal pattern	Seasonal peaks, especially winter/early spring in temperate climates
Pathological basis	Sloughed infected enterocytes causing watery diarrhoea
Diagnosis	NAAT on stool when confirmation is required
Treatment	Symptomatic and supportive management, mainly rehydration

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Rotavirus causes invasive, bloody diarrhoea
- ✓ Watery diarrhoea from enterocyte damage/sloughing and impaired absorption; not invasive or bloody
- ✗ Uncomplicated rotavirus gastroenteritis requires routine antibiotics
- ✓ Supportive rehydration is the mainstay; antibiotics are not routine

Gram-Negative Gastrointestinal Disease

Campylobacter

Main pathogen	Campylobacter jejuni
Sources	Contaminated food, water, and animal sources; poultry is a classic source
Pathogenesis	Mucosal colonisation and intestinal inflammation
Clinical illness	Acute gastroenteritis with gut and systemic features
Complications	Guillain-Barre syndrome and reactive arthritis
Diagnosis	Faecal sampling
Management	Supportive care; antibiotics only for selected severe or higher-risk cases

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Campylobacter enteritis is routinely treated with antibiotics
- ✓ Mostly self-limiting and managed supportively; antibiotics only for selected severe or higher-risk cases
- × Campylobacter has no significant post-infective complications
- ✓ Guillain-Barre syndrome and reactive arthritis are high-yield post-infective complications
- × Campylobacter is diagnosed by serology
- ✓ Faecal sample is the key diagnostic specimen, not serology

Helicobacter pylori

Organism	Curved Gram-negative gastric pathogen
Key virulence mechanism	Urease production raises local pH and protects against acid
Clinical features	Asymptomatic carriage, gastritis, peptic ulcers, gastric carcinoma association
Diagnosis	Biopsy, urea breath test, stool antigen testing, serum antibody testing
Management principle	Eradication therapy with a proton pump inhibitor and antibiotics

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × H. pylori survives gastric acid by intrinsic acid resistance alone
- ✓ Urease production raises local pH, protecting it from acid
- × Positive H. pylori serology after treatment proves active infection
- ✓ Antibodies may persist; use tests of active infection (urea breath test, stool antigen) to confirm eradication
- × H. pylori mainly causes invasive sepsis
- ✓ Chronic gastric colonisation causing gastritis, peptic ulcer disease and gastric carcinoma association

Hepatitis

Hepatitis A

Main transmission route	Faecal-oral spread.
Age relationship	Symptomatic infection is more likely with increasing age.
Viral presence	Virus is shed in faeces and may be present in blood during acute infection.
LFT pattern	Acute hepatitis with deranged LFTs, especially raised transaminases.
Diagnostic marker	Anti-HAV IgM; persists in blood for months.

Management	Supportive care, monitor for severe disease, and involve public health to reduce transmission.
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ A non-jaundiced hepatitis A patient poses no transmission risk
- ✓ Faecal HAV shedding may occur before jaundice is obvious
- ✗ Anti-HAV IgG is the marker of acute hepatitis A
- ✓ Anti-HAV IgM diagnoses acute infection
- ✗ Asymptomatic children with hepatitis A do not contribute to spread
- ✓ Children are often asymptomatic (symptoms increase with age) but can still drive spread

Hepatitis B

Virus	Blood-borne DNA virus causing acute or chronic hepatitis.
Main transmission routes	Blood-borne, sexual and vertical transmission.
HBsAg	Current infection.
Anti-HBc	Past or current natural infection (not vaccination); IgM anti-HBc indicates acute or recent infection.
HBeAg	Active replication and higher infectivity.
Incubation period	Variable; approximately 30-180 days.
LFT pattern	Raised transaminases from hepatocellular injury.
Major complications	Acute liver failure, chronic infection, cirrhosis, hepatocellular carcinoma.
Diagnosis	Serological immunoassay.
Treatment overview	Supportive care for most acute infection; interferons and antivirals for selected chronic infection under specialist care.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Positive HBsAg indicates immunity to hepatitis B
- ✓ HBsAg indicates current infection, not protection
- ✗ HBeAg simply indicates past exposure to hepatitis B
- ✓ HBeAg indicates active viral replication and higher infectivity
- ✗ Hepatitis D can replicate independently of hepatitis B
- ✓ Hepatitis D requires HBsAg from co-existing HBV infection to replicate
- ✗ Raised transaminases define chronic hepatitis B infection
- ✓ Raised transaminases reflect hepatocellular injury; they do not by themselves define chronicity

Hepatitis C

Virus type	Blood-borne RNA virus
Seroprevalence	Antibody evidence of exposure; higher in blood-exposure risk groups
Main transmission	Blood-to-blood contact, especially shared injecting equipment
Clinical pattern	Often mild or silent initially; serious chronic liver outcomes can occur
Diagnosis	HCV antibody immunoassay, followed by HCV RNA to confirm active infection
Treatment overview	Direct-acting antivirals are current standard; interferon/ribavirin are legacy concepts
Transplant relevance	End-stage liver disease or selected hepatocellular carcinoma

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Positive HCV antibody confirms current active infection
- ✓ Antibody shows exposure only; HCV RNA confirms active viraemia
- ✗ Mild or asymptomatic hepatitis C is benign
- ✓ Chronic hepatitis C can still progress to cirrhosis and hepatocellular carcinoma
- ✗ Sexual contact is the main transmission route of hepatitis C
- ✓ Blood-to-blood exposure, especially shared injecting equipment, dominates; sexual transmission is possible but less common

Herpes Simplex and Zoster

Herpes Simplex Virus (HSV)

Transmission	Direct contact with infected secretions or lesions; oral, sexual, and perinatal spread are important routes.
Latency	Virus persists in sensory ganglia and may reactivate.
HSV-1	Classically causes orofacial disease and is a major cause of herpes encephalitis.
HSV-2	Classically causes genital herpes; also relevant to neonatal and CNS disease.
Immunocompromise	Greater risk of severe, persistent, disseminated, or CNS infection.
Encephalitis	MRI supports diagnosis; urgent intravenous aciclovir is the key treatment principle.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Only HSV-2 can cause genital herpes
- ✓ Either HSV-1 or HSV-2 can cause genital infection
- ✗ IV aciclovir should be withheld until MRI confirms herpes encephalitis
- ✓ Start IV aciclovir urgently when herpes encephalitis is strongly suspected; MRI only supports diagnosis
- ✗ HSV infection is always minor in immunocompromised patients
- ✓ Immunocompromise increases risk of severe, persistent, disseminated or CNS HSV disease

Other Herpesviruses

Other herpesviruses to recognise	CMV and EBV
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Varicella Zoster Virus (VZV)

Primary disease	Chickenpox
Reactivation disease	Shingles / herpes zoster
Incubation	Usually 10-21 days
Latency site	Sensory ganglia
Chickenpox rash chronology	Macule → papule → vesicle → pustule → crust
Important complication	VZV pneumonia
Diagnosis	Essentially clinical
Treatment principles	Aciclovir where indicated; post-exposure prophylaxis for susceptible high-risk contacts (oral aciclovir first-line in UK; VZIG in selected cases)

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Shingles is a new external VZV infection
- ✓ Shingles is reactivation of latent VZV from sensory ganglia
- ✗ Chickenpox lesions are all at the same stage at any one time
- ✓ Lesions at multiple stages (macule, papule, vesicle, pustule, crust) coexist
- ✗ VZ immunoglobulin treats established chickenpox
- ✓ VZIG is post-exposure prevention/attenuation in selected susceptible high-risk patients, not treatment

HIV

Clinical Features

Early clinical course	Seroconversion illness may resemble a non-specific viral illness.
Middle phase	Often asymptomatic or associated with persistent lymphadenopathy.
Late clinical course	Progressive immunodeficiency with opportunistic infections.
Co-infection awareness	Think broadly: fungal, viral, bacterial, mycobacterial and protozoal infections.
Core mechanism behind features	Clinical disease reflects progressive loss of immune control.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Non-specific early illness makes HIV unlikely
- ✓ Seroconversion illness is non-specific and can mimic many common viral syndromes
- ✗ The asymptomatic phase of HIV means inactive disease
- ✓ Viral replication and immune damage may continue during the asymptomatic phase
- ✗ HIV patients usually have only one opportunistic infection
- ✓ Broad range of co-existent fungal, viral, bacterial, mycobacterial and protozoal infections may occur

Diagnosis

Main diagnostic basis	Combined HIV antibody and p24 antigen (4th-generation) blood test.
Negative result	Interpret in relation to timing since possible exposure.
Reactive screening result	Requires confirmatory testing before final diagnosis.
Clinical principle	Do not rely on symptoms alone; HIV may be asymptomatic or non-specific early on.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A negative HIV test excludes infection regardless of exposure timing
- ✓ Very recent exposure may give a negative result in the window period; interpret by timing
- ✗ A reactive HIV screening test is a final diagnosis
- ✓ Reactive screening requires confirmatory testing before final diagnosis

Epidemiology

Susceptibility	Requires exposure of mucosa, breached skin, or bloodstream to infectious body fluids.
Important fluids	Blood, semen, vaginal and rectal secretions, and breast milk.

Lifestyle risk factors	Condomless sex, multiple partners, STIs, shared injecting equipment, and blood exposure.
Vertical transmission	May occur in pregnancy, labour/delivery, or breastfeeding.
Major epidemiological modifier	Higher viral load increases infectiousness; suppression with treatment markedly reduces transmission risk.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Membership of a risk group, rather than exposure route, determines HIV transmission
- ✓ The route of exposure of infectious fluid to mucosa, breached skin or bloodstream is what matters
- ✗ HIV spreads by casual contact, shared utensils, coughing or intact skin
- ✓ Requires mucosal, breached-skin or bloodstream exposure to infectious fluids; not casual contact
- ✗ Vertical HIV transmission occurs only in pregnancy and delivery
- ✓ Vertical transmission also includes breastfeeding

Management (Simple Overview Only)

Main therapeutic target	Minimise HIV replication and reduce viral load.
Resistance principle	Incomplete or inconsistent suppression can select resistant virus.
Immune repair	Suppression allows CD4-positive T-cell recovery and improved immune function.
Monitoring concept	Viral load reflects virological control; CD4 count reflects immune reserve.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ HIV is treated with single-drug therapy
- ✓ Combination therapy to achieve durable viral suppression and prevent resistance
- ✗ Starting antiretroviral therapy immediately normalises immune function
- ✓ CD4 recovery may lag behind viral suppression

Pathogenesis

Target cell	CD4-positive T lymphocyte
Main pathogenic process	Progressive T-cell depletion
Clinical consequence	Increasing immunodeficiency and opportunistic infection risk
Monitoring marker	CD4 count

EXAM TRAPS × tempting option ✓ correct answer

- ✗ HIV causes disease mainly through direct tissue destruction
- ✓ Central mechanism is progressive immune failure through CD4-positive T-cell depletion
- ✗ CD4 count is mainly a diagnostic test for HIV
- ✓ CD4 count is used for monitoring and assessing immune compromise; diagnosis is by antibody/p24 antigen test

Klebsiella and Enterobacteriae

Escherichia coli

Main organism type	Gram-negative enteric bacillus
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Key infection site	Urinary tract
UTI virulence	Adherence to uroepithelium plus mechanisms supporting ascent and persistence
CNS relevance	Neonatal and post-operative meningitis
Treatment principle	Culture when appropriate, empirical treatment when urgent, then tailor to sensitivities
Resistance issue	ESBL-producing <i>E. coli</i> may limit standard antibiotic options

EXAM TRAPS × tempting option ✓ correct answer

- ✗ *E. coli* is only a gut organism
- ✓ *E. coli* is also a leading urinary tract pathogen
- ✗ All *E. coli* infections are managed with the same urgency and intensity
- ✓ Cystitis, pyelonephritis, sepsis and meningitis need different levels of urgency and treatment intensity

Klebsiella

Organism	<i>Klebsiella</i> spp., especially <i>K. pneumoniae</i>
Epidemiology	Hospital setting; critical care and ventilator-associated infection are key links
Important sites	Lung and nasal tract
Major clinical concern	<i>Klebsiella</i> pneumonia has high mortality
Management principle	Culture where appropriate, treat promptly, then tailor antibiotics to sensitivities and local resistance patterns

EXAM TRAPS × tempting option ✓ correct answer

- ✗ *Klebsiella* is mainly a community respiratory pathogen
- ✓ Key setting is hospital exposure, especially critical care and ventilator-associated infection
- ✗ *Klebsiella* pneumonia carries low mortality
- ✓ *Klebsiella* pneumonia has high mortality

Salmonella

Primary human pathogen	<i>Salmonella enterica</i>
Sources	Animals, contaminated food or water, and human carriers
Spread	Faecal-oral transmission
Main gut syndrome	Acute gastroenteritis with diarrhoea, abdominal cramps and fever
Systemic syndrome	Enteric fever caused by typhoidal <i>Salmonella</i>
Classic focal complication	Osteomyelitis, especially in sickle cell disease
Treatment principle	Supportive care unless severe, invasive, systemic, or high-risk disease
Containment principle	Food hygiene, hand hygiene, exclusion while infectious, and public health investigation of clusters

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Salmonella causes only diarrhoeal illness
- ✓ Typhoidal Salmonella causes systemic enteric fever
- ✗ Salmonella does not cause osteomyelitis
- ✓ Osteomyelitis is a classic invasive complication, especially in sickle cell disease
- ✗ Uncomplicated non-typhoidal Salmonella gastroenteritis needs routine antibiotics
- ✓ Supportive care and containment; antibiotics only for severe, invasive, systemic or high-risk disease
- ✗ Human carriers are irrelevant to enteric fever transmission
- ✓ Human carriers are an important source for enteric fever transmission and public health control

Legionella

Background to Infection

Primary pathogen	Legionella pneumophila
Reservoir	Warm water and moist heat sources
Transmission	Aerosol inhalation
Susceptibility	Increased by prior morbidity and reduced host defence

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Legionella is primarily spread person-to-person
- ✓ Spread by inhalation of aerosols from environmental warm water sources, not person-to-person
- ✗ Legionella infection is unrelated to an environmental reservoir
- ✓ Warm water and moist heat sources are the central reservoir

Clinical Features and Diagnosis

Severity spectrum	Mild febrile illness to severe pneumonia
Classic clinical pattern	Atypical pneumonia with prominent systemic features
Common systems	Respiratory, systemic, gastrointestinal, neurological
Respiratory diagnosis	Culture of sputum or bronchoalveolar aspirate
Serological diagnosis	Antibody response, ideally rising titre on paired samples

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Legionella causes a purely respiratory illness
- ✓ Gastrointestinal and neurological features are common clues alongside atypical pneumonia
- ✗ A single early negative serology excludes Legionella
- ✓ Antibody response takes time; rising titre on paired samples is ideal
- ✗ Routine sputum culture will grow Legionella without laboratory notice
- ✓ The laboratory must be alerted when Legionella is suspected for respiratory culture

Management and Prevention

Medical management	Treat as potentially severe pneumonia with Legionella-active antibiotics and supportive care.
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Relevant antibiotic classes	Macrolide or respiratory fluoroquinolone, guided by local policy and specialist advice.
Prevention focus	Control growth in water systems and prevent inhalation of contaminated aerosols.
Transmission implication	Patient isolation is not the main control measure because spread is environmental rather than routine person-to-person.
Public health	Notify, investigate possible sources, identify clusters and ensure environmental remediation.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Legionella prevention centres on droplet precautions between patients
- ✓ Key source is contaminated aerosolised water; control water systems, not patient isolation
- ✗ A single Legionella case has no public health significance
- ✓ A single case may indicate shared environmental exposure; notify and investigate sources
- ✗ A beta-lactam alone reliably treats Legionella
- ✓ Treatment must include an agent active against atypical intracellular organisms (macrolide or respiratory fluoroquinolone)

Malaria

Clinical Features

Core clinical rule	Think malaria in a febrile returning traveller.
Presentation	Often non-specific: fever, sweats, headache, myalgia, malaise and gastrointestinal symptoms.
Do not rely on	A classical fever periodicity; it may be absent.
Most severe species	Plasmodium falciparum.
Major falciparum risks	Cerebral malaria, severe anaemia, acidosis, hypoglycaemia, renal failure and respiratory distress.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Malaria requires a cyclical fever pattern before it is considered
- ✓ Imported malaria often presents non-specifically; classical periodicity may be absent
- ✗ Travel history is unnecessary in fever with gastrointestinal or sepsis-like features
- ✓ Always take travel history; think malaria in a febrile returning traveller
- ✗ All Plasmodium species cause equally severe disease
- ✓ Plasmodium falciparum is the key species causing rapid, severe and potentially fatal disease

Diagnosis

Primary diagnostic method	Peripheral blood film microscopy
Core requirement	Serial blood films for reliable diagnosis
Reason for repetition	Low or fluctuating parasitaemia may produce an initially negative film
Species and burden	Thin film helps identify Plasmodium species and quantify parasitaemia
Clinical trigger	Fever or systemic illness after travel to an endemic area

EXAM TRAPS × tempting option ✓ correct answer

- × One negative blood film excludes malaria
- ✓ Serial blood films are needed; low or fluctuating parasitaemia may give an initially negative film
- × Rapid diagnostic tests fully replace blood film microscopy for malaria
- ✓ Peripheral blood film microscopy remains primary; RDTs are not a complete substitute
- × Malaria testing should await a classical fever cycle
- ✓ Test any fever or systemic illness after travel to an endemic area; presentation may be non-specific

Epidemiology and Pathogenesis

Source of infection	Mosquito bite introducing sporozoites
Vector	Female Anopheles mosquito
Early phase	Pre-erythrocytic multiplication in hepatocytes
Blood phase	Merozoite infection of red blood cells
Dormant species	Plasmodium vivax and Plasmodium ovale
Dormant form	Hypnozoite within hepatocytes

EXAM TRAPS × tempting option ✓ correct answer

- × Malaria infection begins in red blood cells
- ✓ Sporozoites first establish the pre-erythrocytic phase in hepatocytes
- × Recurrent P. vivax or P. ovale malaria always reflects reinfection
- ✓ Relapse may arise from dormant liver hypnozoites in P. vivax and P. ovale
- × Dormant malaria stages persist within red blood cells
- ✓ Dormant hypnozoites reside within hepatocytes

Therapy

Main safety concern	Falciparum malaria can become rapidly severe
Treatment determinants	Species, severity, resistance risk, travel exposure, and host factors

EXAM TRAPS × tempting option ✓ correct answer

- × Falciparum malaria is usually mild
- ✓ Falciparum is the species most strongly associated with severe and potentially fatal disease
- × Non-falciparum malaria needs no species-specific management
- ✓ May need species-specific treatment, including relapse prevention against dormant liver stages

Measles, Mumps and Rubella

Measles

Transmission	Respiratory droplets and airborne spread
Incubation	About 10-12 days to prodrome; about 14 days to rash; range approximately 7-21 days
Infectious period	About 4 days before to 4 days after rash onset
Typical presentation	Fever, cough, coryza, conjunctivitis, Koplik spots, then descending maculopapular rash

Subsequent immunity	Usually long-lasting after natural infection
Important complication	Subacute sclerosing panencephalitis
Prevention	Routine UK measles-containing vaccination schedule; two doses

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Measles becomes infectious only once the rash appears
- ✓ Infectious from about 4 days before to 4 days after rash onset, including the prodrome
- ✗ Measles spreads by droplets only
- ✓ Airborne respiratory spread is central to its high contagiousness
- ✗ SSPE is the acute encephalitis of measles
- ✓ SSPE is a delayed neurological complication, distinct from acute encephalitis

Mumps

Transmission	Respiratory droplets, saliva and close contact
Incubation	Typically 16-18 days; range about 12-25 days
Infectious period	Several days before and after onset of parotid swelling
Typical presentation	Fever, malaise and painful parotid swelling
Subsequent immunity	Usually long-lasting after natural infection
Key complications	Orchitis and aseptic meningitis
Prevention	Two-dose mumps-containing combined vaccine schedule; traditionally MMR

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Mumps infectivity is timed from rash onset
- ✓ Mumps infectivity is anchored to parotid swelling (several days before and after); measles and rubella anchor to rash
- ✗ Mumps affects only the salivary glands
- ✓ Orchitis and aseptic meningitis are key complications

Rubella

Transmission	Respiratory droplets / close contact
Incubation	About 14-21 days
Infectious period	Begins before rash; continues for several days after rash onset
Immunity	Usually long-lasting after infection; vaccine-preventable
Typical presentation	Mild febrile rash illness with lymphadenopathy and possible arthralgia
Pregnancy risk	Congenital rubella syndrome, highest risk in 1st trimester
Prevention	MMR-containing vaccination as part of the UK schedule

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Rubella's main significance is its rash
- ✓ Major significance is fetal harm: congenital rubella syndrome in pregnancy
- × Rubella becomes infectious only once the rash appears
- ✓ Infectivity begins before the rash and continues several days after onset
- × Third trimester rubella carries the highest risk of congenital defects
- ✓ First trimester is the highest-risk period for congenital rubella syndrome

Neisseria

Neisseria gonorrhoeae

Organism	Gram-negative diplococcus
Transmission	Sexual mucosal contact; neonatal exposure during delivery
Pathogenesis	Adherent pili and surface adhesins trigger localised mucosal inflammation
Clinical pattern	Urethritis, cervicitis, rectal/pharyngeal infection, conjunctivitis, PID or epididymo-orchitis
Diagnosis	NAAT for detection; culture for susceptibility; Gram stain useful in selected symptomatic discharge
Not routine	Serology for uncomplicated gonorrhoea
Treatment principle	Current UK first-line treatment is ceftriaxone 1 g IM as a single dose when susceptibility is unknown
Public health	Partner notification, STI screening, resistance surveillance and specialist management of treatment failure

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Serology is a standard diagnostic test for gonorrhoea
- ✓ Diagnosis uses NAAT and culture; serology is not routine
- × NAAT alone suffices for gonorrhoea antimicrobial susceptibility
- ✓ Culture is needed for antimicrobial susceptibility testing; NAAT is for detection
- × Treating the index gonorrhoea patient alone is sufficient
- ✓ Partner notification is central to management and preventing reinfection
- × Rectal and pharyngeal gonorrhoea are always symptomatic
- ✓ Extra-genital (rectal and pharyngeal) gonorrhoea may be asymptomatic

Neisseria meningitidis

Organism	Gram-negative diplococcus
Reservoir	Human nasopharyngeal carriage
Spread	Respiratory droplets and close contact with secretions
Age peaks	Infants under 1 year; smaller peak at 15-19 years
Major UK groups	B, C, W and Y
Pathogenesis	Capsule-mediated invasion with complement activation and cytokine release
Main syndromes	Meningitis and meningococcal septicaemia
Diagnosis	Blood culture, CSF analysis, rash aspirate
Treatment	Prompt parenteral antibiotics, usually ceftriaxone in hospital

Prevention	MenB and MenACWY vaccination; chemoprophylaxis for close contacts
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EXAM TRAPS × tempting option ✓ correct answer

- × Nasopharyngeal meningococcal carriage indicates disease
- ✓ Asymptomatic carriage is common; invasive disease is uncommon but severe
- × Meningococcal disease should be considered only once a rash appears
- ✓ Early presentations may be non-specific without rash
- × Antibiotics for suspected meningococcal disease should await lumbar puncture or imaging
- ✓ Give prompt parenteral antibiotics (usually ceftriaxone) without delay for LP or imaging
- × Complement deficiency does not affect meningococcal risk
- ✓ Terminal complement deficiency or complement inhibition increases susceptibility to invasive meningococcal disease

Pertussis (Bordetella Pertussis)

Clinical Features

Classic syndrome	Prolonged paroxysmal cough illness
Early phase	Coryza and mild cough, often resembling viral URTI
Paroxysmal phase	Severe cough bursts, inspiratory whoop, post-tussive vomiting and exhaustion
Infant presentation	Apnoea, cyanosis, choking or feeding difficulty may dominate
Major complications	Pneumonia, apnoea, seizures, encephalopathy, dehydration and weight loss

EXAM TRAPS × tempting option ✓ correct answer

- × Pertussis cannot be diagnosed without an inspiratory whoop
- ✓ Whoop may be absent in infants, adults and partially immunised patients
- × A child who looks well between coughing episodes does not have pertussis
- ✓ Pertussis causes severe paroxysms with relatively normal intervals

Diagnosis and Management

Early diagnostic sample	Pernasal swab from the nasopharynx
Culture	Confirms infection if positive; sensitivity is limited
Late confirmation	Serology, interpreted in the clinical and vaccination context
Antibiotic role	Limited symptomatic benefit once paroxysmal cough is established
Exam principle	Early antibiotics reduce carriage/transmission more than they alter established cough

EXAM TRAPS × tempting option ✓ correct answer

- × A negative pertussis culture excludes infection
- ✓ Culture sensitivity is limited, falls with time and depends on sample quality
- × Antibiotics rapidly stop the pertussis whoop
- ✓ Late antibiotics have limited effect on established toxin-mediated cough; they mainly reduce carriage/transmission
- × Serology is the best early test for pertussis
- ✓ Early test is pernasal swab; serology is useful later once antibody response develops

Epidemiology and Pathogenesis

Organism	<i>Bordetella pertussis</i>
Syndrome	Whooping cough
Transmission	Respiratory droplet spread
Epidemic pattern	Recurrent epidemics, influenced by high transmissibility and waning or incomplete immunity
Attachment	Adhesins bind to ciliated respiratory epithelium
Disease mechanism	Exotoxins impair host defence and damage mucociliary clearance

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Pertussis is primarily an invasive deep tissue infection
- ✓ Pathology is mucosal adherence to ciliated epithelium plus toxin-mediated airway dysfunction
- ✗ Vaccination eliminates pertussis from the community
- ✓ Waning or incomplete immunity allows recurrent epidemics
- ✗ Infant pertussis always presents with a classic whoop
- ✓ Severe infant pertussis may present atypically with apnoea, cyanosis or feeding difficulty

Pseudomonas

Background and Source

Principal pathogen	<i>Pseudomonas aeruginosa</i>
Main source association	Moist hospital environments
Reservoir concept	Wet areas and water-associated equipment can support persistence

Basis of Infection

Mechanism	Microbiological effect	Clinical meaning
Cytotoxins	Direct injury to host cells	Barrier breakdown, cell death and local inflammation
Damaging proteases	Breakdown of host proteins and tissue structure	Destructive local invasion and impaired host defence
Combined effect	Cell injury plus protein degradation	Persistent, tissue-damaging infection in susceptible sites

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ *Pseudomonas* infection is explained solely by its moist-environment source
- ✓ Basis of infection is cytotoxin- and protease-mediated tissue damage; source matters but is not the mechanism

Clinical Features and Diagnosis

Main clinical sites	Eye, ear, skin, bone and CNS
Major invasive risk	Septicaemia
Diagnostic basis	Culture

Specimen principle	Sample the suspected site of infection; take blood cultures if septicaemia is suspected
Interpretation	Correlate culture growth with clinical features to avoid confusing colonisation with infection

EXAM TRAPS × tempting option ✓ correct answer

- ✗ *Pseudomonas* is only a respiratory or hospital-water organism
- ✓ Also infects eye, ear, skin, bone and CNS, and can cause septicaemia
- ✗ Any positive superficial *Pseudomonas* culture indicates definite infection
- ✓ Correlate with clinical features to distinguish colonisation from infection

Treatment and Hospital Implications

Core treatment issue	High resistance to antibiotics
Treatment principle	Use appropriate antipseudomonal therapy, guided by susceptibility results
Hospital implication	Moist reservoirs and equipment may contribute to persistence and spread
Control focus	Infection control plus antimicrobial stewardship

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Any broad-spectrum antibiotic will cover *Pseudomonas*
- ✓ Highly resistant; use specific antipseudomonal therapy guided by susceptibility results
- ✗ *Pseudomonas* is only a patient-level problem
- ✓ Moist hospital reservoirs and equipment have wider infection-control implications

Respiratory Viruses

Influenza and Parainfluenza

Influenza antigenic change	Drift causes recurrent seasonal disease; shift can cause pandemics.
Influenza incubation	Usually 1-3 days.
Influenza symptoms	Abrupt fever, chills, headache, myalgia, malaise, sore throat and dry cough.
Influenza complications	Bronchitis, pneumonia, secondary bacterial pneumonia and otitis media in children; severe systemic complications are less common.
Parainfluenza incubation	Usually 2-6 days.
Parainfluenza key presentation	Croup in young children, plus other upper and lower respiratory tract illness.
Diagnosis	Essentially clinical.
Prevention	Annual influenza vaccination for eligible groups; no routine parainfluenza vaccine.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Antigenic drift causes influenza pandemics
- ✓ Drift is gradual causing seasonal disease; shift is abrupt and associated with pandemics
- ✗ Influenza is clinically just a common cold
- ✓ Abrupt fever with prominent systemic symptoms such as myalgia and severe malaise is characteristic
- ✗ Influenza is the classic viral cause of croup
- ✓ Parainfluenza is the classic viral association of croup

Respiratory Syncytial Virus (RSV)

Main age group	Young children, especially infants.
Classic syndrome	Bronchiolitis.
Spread	Respiratory droplets and contact with infected secretions via hands or contaminated surfaces.
Typical symptoms	Coryza, cough, fever, wheeze, tachypnoea, increased work of breathing and feeding difficulty.
Severe signs	Hypoxia, apnoea in young infants, exhaustion, dehydration or pneumonia.
Diagnosis	Usually clinical in a typical presentation.
Ribavirin	Limited role; consider only in severe RSV infection under specialist guidance.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × RSV is just another mild cold virus
- ✓ RSV causes bronchiolitis and severe lower respiratory tract disease in young children
- × Ribavirin is routine treatment for bronchiolitis
- ✓ Ribavirin has a limited role, only in selected severe RSV under specialist guidance
- × Uncomplicated RSV needs bacterial culture and antibiotics
- ✓ Diagnosis is usually clinical and treatment supportive

Rhinovirus

Epidemiology	Many serotypes; repeated infections are common
Clinical features	Common cold symptoms, usually mild and upper respiratory
Viral excretion	Most relevant during symptomatic illness
Diagnosis	Clinical diagnosis
Immunity	Multiple serotypes limit long-term broad protection

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × One rhinovirus infection gives lasting protection against future colds
- ✓ Many serotypes limit broad protection; repeated infections are common
- × Uncomplicated common cold requires laboratory investigation
- ✓ Rhinovirus diagnosis is clinical
- × Recurrent common colds indicate abnormal immunity
- ✓ Recurrence is expected because serotype-specific immunity is not broadly protective

Streptococci and Staphylococci

Alpha-Haemolytic Streptococci

Main group	Viridans-group alpha-haemolytic streptococci
Normal reservoir	Oral flora
Key disease association	Subacute infective endocarditis
Mechanism	Bacteraemia with adherence to abnormal endocardial surfaces

Procedural issue	Procedures may cause bacteraemia; UK practice does not recommend routine prophylaxis solely for IE prevention
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EXAM TRAPS × tempting option ✓ correct answer

- ✗ Viridans streptococci are beta-haemolytic like *S. pyogenes*
- ✓ Viridans group are alpha-haemolytic; *Streptococcus pyogenes* is beta-haemolytic
- ✗ Isolation of oral streptococci is automatically pathological
- ✓ They are normal oral flora; clinical context determines significance
- ✗ Antibiotic prophylaxis is routinely required before dental procedures in the UK
- ✓ Current UK practice does not recommend routine prophylaxis solely for infective endocarditis prevention

Staphylococci

Staphylococcus aureus	A virulent, pyogenic organism: abscesses and cellulitis are common; invasive disease includes bacteraemia, pneumonia, bone and joint infection, and endocarditis. Spread is mainly by contact and entry through breached barriers.
Staphylococcus epidermidis	A skin commensal that becomes pathogenic on foreign material: line and prosthetic-device infection are the key associations. Biofilm formation explains persistence and difficulty eradicating infection.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Every *S. epidermidis* blood culture indicates true sepsis
- ✓ Frequent skin contaminant; repeated positives and compatible clinical context favour true infection
- ✗ Staphylococcal infection is limited to skin disease
- ✓ *S. aureus* causes serious invasive infection including bacteraemia, pneumonia, bone/joint infection and endocarditis
- ✗ *S. aureus* is the typical organism in intravascular line or prosthesis infection
- ✓ Think *S. epidermidis*: a skin commensal forming biofilm on foreign material

Streptococci

Organism	Principal clinical features	Methods of spread
Streptococcus pneumoniae	Community-acquired pneumonia; otitis media; sinusitis; bacteraemia; sepsis; meningitis	Respiratory droplets and respiratory secretions; local spread from nasopharynx; bloodstream invasion
Streptococcus pyogenes	Pharyngitis; scarlet fever; impetigo; cellulitis; erysipelas; necrotising fasciitis; toxic shock; post-streptococcal immune disease	Respiratory droplets in throat infection; direct contact with infected skin lesions; invasion through breached skin

Tuberculosis

Clinical Features

Clinical breadth	Pulmonary, extrapulmonary, systemic, and disseminated disease are all possible.
Lung	Chronic cough, sputum, haemoptysis, fever, night sweats, weight loss.
Kidney	Sterile pyuria and urinary tract symptoms may occur.
Spine	Chronic back pain, vertebral involvement, deformity, abscess, neurological risk.

Gut	Abdominal pain, weight loss, altered bowel habit, obstruction-like features.
CNS	Meningitis-like illness, confusion, seizures, cranial nerve involvement.
Miliary TB	Disseminated disease; may occur without active lung infection.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Extrapulmonary presentation makes tuberculosis unlikely
- ✓ TB can be pulmonary, extrapulmonary, systemic or disseminated
- ✗ Miliary TB requires obvious active pulmonary disease
- ✓ Miliary (disseminated) TB may occur without active lung infection
- ✗ Chronic constitutional symptoms with organ involvement are non-specific and not suggestive of TB
- ✓ Chronic fever, night sweats and weight loss with compatible organ involvement should prompt consideration of TB

Laboratory Identification

Core stain	Ziehl-Neelsen stain
Stain target	Acid-fast bacilli
Core molecular method	Nucleic acid amplification technique, such as PCR
Reason molecular testing is useful	Rapid identification where the organism may be slow-growing

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A negative Ziehl-Neelsen stain excludes TB
- ✓ Sensitivity depends on organism load, specimen quality and disease site
- ✗ TB NAAT provides full treatment and susceptibility guidance
- ✓ NAAT supports rapid identification; susceptibility and definitive microbiology follow laboratory pathways

Management

Standard regimen	2HRZE/4HR for drug-susceptible TB
First 2 months	Isoniazid, rifampicin, pyrazinamide, ethambutol
Next 4 months	Isoniazid and rifampicin
Core principle	Prolonged combination therapy prevents relapse and resistance
HIV relevance	Higher reactivation risk; specialist coordination because of interactions and prophylaxis needs

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Active TB is treated with a short course of a single antibiotic
- ✓ Multiple drugs over months: 2HRZE/4HR for drug-susceptible TB
- ✗ Initial-phase adult TB treatment is isoniazid, rifampicin and pyrazinamide only
- ✓ Ethambutol is included in the initial 2-month phase while susceptibility is established
- ✗ Latent TB is treated with the full multidrug active TB regimen
- ✓ Preventive treatment for latent TB differs from the full multidrug regimen for active TB

Transmission and Establishment in Host

Route of spread	Airborne aerosol inhalation.
Initial establishment	Bacilli reach alveoli and survive within macrophages.
Main protective immunity	T-cell-mediated activation of macrophages.
Latency	Contained infection with viable bacilli persisting without active disease.
Reactivation	Occurs when cellular immunity falls.
Cavitation and systemic effects	Mainly consequences of intense host immune inflammation.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Tuberculosis is spread by simple droplet transmission
- ✓ Airborne aerosol inhalation
- × Antibody is the main protective immunity against TB
- ✓ T-cell-mediated activation of macrophages is the main protection
- × Latent tuberculosis means the infection is eradicated
- ✓ Latency is contained infection with viable bacilli that can reactivate when cellular immunity falls
- × TB cavitation is caused by a bacterial toxin
- ✓ Cavitation results mainly from intense host immune inflammation

Worms

Roundworms and Hookworms

Epidemiology	Poor sanitation and contaminated soil are central.
Roundworm acquisition	Ingestion of infective eggs.
Hookworm acquisition	Skin penetration by larvae, often through bare feet.
Migration	Larvae migrate through the body, with lung involvement before return to the gut.
Parasite load	Heavier burden causes more severe symptoms and complications.
Diagnosis	Visualisation in stool sample.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Hookworm is acquired by ingesting eggs
- ✓ Hookworm is acquired by larval skin penetration, often through bare feet; roundworm by egg ingestion
- × Intestinal helminths never involve the lungs
- ✓ Larvae migrate through the lungs before returning to gut, causing cough or eosinophilia
- × Parasite load does not affect helminth complications
- ✓ Heavier burden drives major complications such as obstruction or anaemia

Tapeworms (*Taenia saginata* – beef; *Taenia solium* – pork)

Species	<i>T. saginata</i> = beef; <i>T. solium</i> = pork
Epidemiology	Linked to food hygiene, undercooked meat and sanitation
Basis of intestinal infection	Ingestion of cysticerci in infected beef or pork
Egg ingestion	Important for <i>T. solium</i> cysticercosis rather than simple taeniasis
Clinical features	Often asymptomatic; mild GI symptoms; visible segments in stool

Diagnosis	Stool visualisation; CT/MRI if complicated disease suspected
Management	Specialist advice; antihelminthic therapy for intestinal infection

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Eating cysticerci in pork causes cysticercosis
- ✓ Eating cysticerci causes intestinal taeniasis; *T. solium* egg ingestion causes larval tissue disease (cysticercosis)
- ✗ Imaging is routine for uncomplicated intestinal tapeworm
- ✓ Stool visualisation is key; CT/MRI only if complications suspected
- ✗ Suspected *T. solium* with neurological symptoms is a simple worm infection
- ✓ Neurological symptoms suggest cysticercosis; specialist advice is required

Threadworm (*Enterobius vermicularis*)

Organism	<i>Enterobius vermicularis</i> , a nematode.
Main site	Large intestine.
Key symptom	Perianal itching, often worse at night.
Spread	Eggs transferred by scratching, fingers, nails, bedding, clothing and contaminated surfaces.
Reinfection mechanism	Ingestion of eggs from contaminated hands or environment.
Management principle	Anti-helminthic treatment plus hygiene measures and family-wide consideration.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Threadworm causes disease by invasive tissue destruction
- ✓ Intestinal habitation with perianal egg-laying; itch-driven scratching spreads eggs
- ✗ Treat only the symptomatic child with threadworm
- ✓ Consider the whole household; asymptomatic contacts may perpetuate reinfection
- ✗ Recurrent threadworm symptoms indicate anti-helminthic drug resistance
- ✓ Reinfection from persistent eggs and poor hygiene is much more likely

Yeasts and Fungi

Candida

Organism type	Yeast; <i>Candida</i> spp. commonly exist as commensal flora.
Main risk factors	Antibiotic use, immunocompromise and intravascular catheters.
Local disease	Oral, vulvovaginal and moist-skin candidiasis.
Systemic disease	Non-specific fever or sepsis-like illness, particularly in vulnerable hospitalised patients.
Line implication	<i>Candida</i> may enter or persist in the bloodstream via an intravascular catheter.

EXAM TRAPS × tempting option ✓ correct answer

- × Any Candida-positive swab indicates candidal infection
- ✓ Candida from a non-sterile site may simply indicate colonisation (commensal flora)
- × Antibiotic use is unrelated to Candida overgrowth
- ✓ Antibiotics suppress normal bacterial flora, a key reason Candida overgrowth occurs
- × Candida in blood culture is a harmless contaminant
- ✓ With an intravascular line or immunocompromise, candidaemia may be clinically significant

Cryptococcus

Organism	Encapsulated yeast; <i>Cryptococcus neoformans</i> is the classic human pathogen.
Exposure association	Pigeon droppings and pigeon fanciers.
High-risk host	Immunocompromised patients, including those with lymphoma.
Typical features	Pulmonary symptoms, subacute meningitis and non-specific disseminated disease.
Most important severe syndrome	Cryptococcal meningitis.
Usual drug agents	Fluconazole; amphotericin B plus flucytosine for severe or CNS disease.

EXAM TRAPS × tempting option ✓ correct answer

- × *Cryptococcus* has no characteristic environmental exposure
- ✓ Pigeon droppings (pigeon fanciers) are the classic environmental clue
- × *Cryptococcus* causes respiratory infection only
- ✓ In immunocompromised patients, CNS dissemination and meningitis are central concerns
- × Lymphoma does not increase risk of cryptococcal infection
- ✓ Lymphoma impairs cellular immunity, increasing risk of severe cryptococcal infection

Dermatophytes

Organism group	Anthropophilic dermatophytes
Transmission	Close personal contact
Tinea corporis	Ringworm of the body: annular scaly skin lesion
Tinea capitis	Ringworm of the scalp: scaling, broken hairs and alopecia
Tinea pedis	Athlete's foot: interdigital scaling, maceration and itch
Diagnosis	Skin, hair or nail clippings/scrapings
Treatment principle	Topical therapy for many cases; systemic therapy occasionally

EXAM TRAPS × tempting option ✓ correct answer

- × Ringworm is caused by a worm
- ✓ Ringworm is a clinical term for dermatophyte (fungal) infection
- × A superficial swab is the diagnostic sample for dermatophyte infection
- ✓ Skin scrapings, hair or nail clippings from affected keratinised tissue
- × All tinea infections, including tinea capitis, are managed topically
- ✓ Tinea capitis often needs systemic treatment because hair shafts are involved

NOW TEST IT

Reading Microbiology is not the same as answering it under time pressure.

Organism, toxin, test, treatment: Microbiology rewards fast pattern recognition. Build it with syllabus-mapped MCQs and per-question timing.

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CHAPTER 5

Pathology

5 curriculum topics · 49 subtopics · 158 exam traps

Inflammatory Response · Immune Response · Infection · Wound Healing · Haematology

PATHOLOGY · TOPIC 1 OF 5

Inflammatory Response

Normal Inflammatory Response

Features of Normal Inflammation

Purpose	Protects tissue by containing injury, clearing harmful agents and initiating repair.
Vascular phase	Vasodilation and increased permeability produce heat, redness and swelling.
Cellular phase	Neutrophils arrive early; macrophages clear debris and support resolution.
Exudate	Protein-rich inflammatory fluid containing plasma proteins and immune mediators.
Appropriate response	Proportionate, localised, effective and self-limiting.
Resolution	Removal of trigger, clearance of inflammatory cells, drainage of fluid and tissue repair.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Normal inflammation is inherently harmful
- ✓ Inflammation is protective; it becomes pathological when excessive, persistent or misdirected
- × Inflammatory exudate is a protein-poor transudate
- ✓ Exudate is protein-rich, reflecting increased vascular permeability
- × Acute inflammation consists only of neutrophil recruitment
- ✓ Vascular changes (vasodilation, increased permeability) are essential early events before the cellular phase

Abnormal Inflammatory Response

Features of Abnormal Inflammation

Normal inflammation	Protective, proportionate, localised and resolves after the stimulus is removed.
Abnormal inflammation	Excessive, persistent, systemic or misdirected response causing host injury.
Acute danger	Mediator excess, vascular leak, oedema, pain, tissue damage and shock physiology.
Chronic danger	Macrophage and lymphocyte persistence with fibrosis, scarring and loss of architecture.
ED relevance	Sepsis, severe infection, allergic airway inflammation and autoimmune flares.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Inflammation always indicates infection
- ✓ Infection is one trigger; sterile injury, allergy and autoimmunity also drive inflammation
- ✗ A stronger inflammatory response is always more beneficial
- ✓ Excessive inflammation can be the main cause of tissue and organ injury
- ✗ Chronic inflammation is simply prolonged acute inflammation
- ✓ Different cellular pattern: macrophages and lymphocytes, with repair and fibrosis prominent

Inflammatory Markers

Antinuclear Factor (ANF)

Alternative name	ANF is commonly referred to as ANA.
Nature	Autoantibodies against nuclear antigens.
Main association	Systemic lupus erythematosus and other connective tissue diseases.
Strength	Useful screening marker when clinical suspicion is present.
Limitation	Positive result is not diagnostic and may be non-specific.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A positive ANF is diagnostic of SLE
- ✓ Supportive only when the clinical context fits; not diagnostic alone
- ✗ ANF is the key marker of rheumatoid arthritis
- ✓ Rheumatoid factor and anti-CCP for rheumatoid arthritis; ANF points to systemic connective tissue disease
- ✗ A positive ANF occurs only in SLE
- ✓ Also positive in other autoimmune diseases and occasionally without a defined autoimmune diagnosis

C-Reactive Protein (CRP)

What is CRP?	A liver-derived positive acute-phase reactant.
What stimulates it?	Inflammatory cytokines, especially interleukin-6.
What does it indicate?	Presence and approximate burden of inflammation.
What does it not identify?	The exact cause, site or organism.
Best use in ED	Adjunct to assessment and monitoring, especially when interpreted as a trend.
Main danger	False reassurance from a low early CRP or overdiagnosis of infection from a raised CRP.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A raised CRP indicates bacterial infection
- ✓ Many non-infective inflammatory conditions raise CRP; it does not identify cause
- ✗ A normal early CRP excludes serious disease
- ✓ Not when symptoms, signs or physiology are concerning; early CRP may be falsely reassuring
- ✗ A given CRP value has the same meaning in any context
- ✓ CRP must be interpreted with the clinical context, not in isolation
- ✗ A falling CRP alone proves recovery
- ✓ Clinical deterioration outweighs a falling biochemical trend

Rheumatoid Factors

Nature	Autoantibody against the Fc portion of IgG.
Common class	Usually IgM.
Pathological association	Autoimmune inflammation and immune complex formation.
Classic disease link	Rheumatoid arthritis.
Main limitation	False positives and false negatives occur.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Rheumatoid factor is diagnostic of rheumatoid arthritis
- ✓ It is supportive, not specific; false positives occur
- × Negative rheumatoid factor excludes rheumatoid arthritis
- ✓ Seronegative rheumatoid arthritis can occur
- × Rheumatoid factor is a general acute-phase reactant like CRP
- ✓ It is an autoantibody (usually IgM) against the Fc portion of IgG
- × Fever and joint pain with positive rheumatoid factor excludes infection
- ✓ Septic arthritis must still be considered despite a positive rheumatoid factor

PATHOLOGY · TOPIC 2 OF 5

Immune Response

Normal Immune Response

Features of the Normal Immune Response

Innate immunity	Fast, broad defence using barriers, phagocytes, complement, natural killer cells and inflammation.
Adaptive immunity	Specific lymphocyte response with clonal expansion and memory.
Humoral response	B cells become plasma cells; antibodies neutralise, opsonise and activate complement.
Cellular response	T cells coordinate immunity and cytotoxic T cells kill infected or abnormal host cells.
Memory	Memory B and T cells allow a stronger and faster response on re-exposure.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × The immune response consists only of antibodies
- ✓ Cellular (T-cell) immunity is equally important alongside humoral immunity
- × Innate immunity is antigen-specific like adaptive immunity
- ✓ Innate immunity is rapid but broad, not antigen-specific; specificity and memory belong to adaptive immunity
- × Humoral immunity is the main defence against intracellular infection
- ✓ Humoral targets extracellular organisms and toxins; intracellular infection requires cellular immunity

Abnormal Immune Response

Anaphylactoid Reactions

Definition	An anaphylaxis-like systemic reaction that is not IgE-mediated.
Core mechanism	Direct mast cell activation.
Clinical presentation	Identical to anaphylaxis.
Common ED triggers	Contrast media, opioids and NSAIDs.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anaphylactoid reactions require previous sensitisation
- ✓ They can occur on first exposure, without prior sensitisation
- ✗ Anaphylactoid reactions are IgE-mediated
- ✓ Non-IgE direct mast cell activation (e.g. contrast media, opioids, NSAIDs)

Anaphylaxis

Reaction type	Severe Type I hypersensitivity reaction.
Core immune mechanism	IgE-mediated activation of mast cells and basophils.
Cellular event	Rapid degranulation with release of inflammatory mediators.
Key mediators	Histamine, leukotrienes and prostaglandins.
Vascular effects	Vasodilation and increased vascular permeability.
Respiratory effects	Bronchospasm and airway oedema.
Clinical consequences	Urticaria, angioedema, hypotension and cardiovascular collapse.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anaphylaxis is primarily a skin reaction
- ✓ Systemic reaction that may involve airway, breathing and circulation
- ✗ Classic anaphylaxis is a non-IgE direct mast cell reaction
- ✓ IgE-mediated mast cell and basophil degranulation (Type I hypersensitivity)
- ✗ Bronchospasm in anaphylaxis is caused by vasodilation
- ✓ Bronchial smooth muscle constriction causes bronchospasm; vasodilation causes hypotension

Hypersensitivity

Type I	Immediate allergy: IgE, mast cells, histamine; think anaphylaxis, urticaria, angioedema and bronchospasm.
Type II	Antibody against cells or fixed tissues; think haemolysis, transfusion reactions and receptor-targeting autoimmune disease.
Type III	Immune complexes deposit in tissues; think vasculitis, glomerular inflammation, arthralgia and serum sickness-like patterns.
Type IV	Delayed T-cell response; think contact dermatitis, tuberculin reaction and delayed drug eruptions.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Anaphylactoid reactions are Type I IgE-mediated hypersensitivity
- ✓ Clinically identical to anaphylaxis but not IgE-mediated
- ✗ SLE tissue damage is classically Type II hypersensitivity
- ✓ Immune complex disease such as SLE is classically Type III in many tissue manifestations
- ✗ Type IV hypersensitivity is antibody-mediated
- ✓ Type IV is delayed and T-cell mediated

PATHOLOGY · TOPIC 3 OF 5

Infection

Bone and Joint Infections

Infection of Bones and Joints

Feature	Osteomyelitis	Septic arthritis
Main pathology	Bone infection with inflammatory infiltrate, vascular compromise and bone necrosis.	Joint-space infection with synovial inflammation and rapid cartilage destruction.
Classic organism	Staphylococcus aureus.	Staphylococcus aureus.
Important associations	Salmonella in sickle cell disease; Pseudomonas in IV drug use or diabetic feet; TB in vertebral disease.	Gonococcal infection in sexually active young adults; Gram-negative organisms in neonates and older adults.
Key investigation	MRI.	Joint aspiration.
Exam phrase	Sequestrum and involucrum.	Proteolytic enzymes destroy cartilage.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ A normal early X-ray excludes osteomyelitis
- ✓ Periosteal reaction is a late sign; MRI is the key investigation
- ✗ Septic arthritis is diagnosed by imaging
- ✓ Joint aspiration is central and mandatory
- ✗ Salmonella is the commonest cause of osteomyelitis in sickle cell disease
- ✓ Staphylococcus aureus is commonest overall; Salmonella is the classic sickle cell association
- ✗ Involucrum is the dead bone in osteomyelitis
- ✓ Sequestrum is dead bone; involucrum is periosteal new bone

Cardiovascular Infections

Endocarditis

Most important lesion	Infected vegetation on valve or endocardial surface
Vegetation contents	Fibrin, platelets and organisms
Classic native-valve organism	Streptococcus viridans / alpha-haemolytic streptococci
Aggressive organism	Staphylococcus aureus

Culture-negative association	HACEK organisms
Major pathological consequences	Valvular destruction, embolic phenomena, abscess formation
Core investigations	Three blood culture sets, echocardiography, Duke criteria, inflammatory markers, urinalysis

EXAM TRAPS × tempting option ✓ correct answer

- × Endocarditis pathology is confined to the valve
- ✓ Systemic embolisation and immune-complex disease are central consequences
- × Inflammatory markers alone can confirm endocarditis
- ✓ They neither identify the organism nor demonstrate vegetations; need blood cultures and echocardiography
- × A single blood culture set suffices for suspected endocarditis
- ✓ Multiple (three) sets from different sites are required

Myocarditis

Most common cause group	Viral infection
Key viral causes	Coxsackie B virus, adenovirus, parvovirus B19, influenza, COVID-19
Key bacterial causes	Staphylococcus aureus, Corynebacterium diphtheriae
Other causes	Drugs, autoimmune disease
Main pathology	Inflammatory cell infiltration of myocardium with myocyte necrosis
Functional consequence	Impaired contractility
Electrical consequence	Arrhythmia and ECG changes
Chronic risk	Dilated cardiomyopathy
Core investigations	ECG, troponin, CRP/ESR, echocardiogram, cardiac MRI, viral serology

EXAM TRAPS × tempting option ✓ correct answer

- × A raised troponin indicates myocardial infarction
- ✓ In myocarditis troponin rises because inflamed myocytes are injured or necrotic
- × Myocarditis causes pump failure but not electrical instability
- ✓ Arrhythmia and ECG changes are key consequences
- × Myocarditis has no chronic sequelae
- ✓ Can progress to dilated cardiomyopathy via persistent injury and ventricular remodelling

Central Nervous System Infections

Encephalitis

Definition	Inflammation of brain parenchyma causing altered brain function.
Most important viral cause	HSV-1, especially in adults.
Other viral causes	Enteroviruses, VZV, EBV, CMV.
Autoimmune type example	Anti-NMDA receptor antibody encephalitis.
Main pathological processes	Direct viral invasion and neuronal destruction; immune-mediated neuronal injury; cerebral oedema.
Classic imaging clue	Temporal lobe changes in HSV encephalitis on MRI.

Core tests	CSF analysis, HSV PCR, MRI brain, EEG.
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EXAM TRAPS × tempting option ✓ correct answer

- × Encephalitis is defined by meningeal inflammation
- ✓ Defined by brain parenchymal involvement; meningism may be absent or secondary
- × CSF HSV PCR is not needed in suspected HSV encephalitis
- ✓ CSF HSV PCR is a central diagnostic investigation
- × CT is the key imaging test for HSV encephalitis
- ✓ MRI classically demonstrates temporal lobe changes
- × All encephalitis is directly infective
- ✓ Anti-NMDA receptor antibody encephalitis is immune-mediated (autoimmune type example)
- × Early CSF findings reliably confirm or exclude encephalitis
- ✓ Early CSF may be non-specific; interpret with the whole clinical picture

Meningitis

Core pathology	Meningeal inflammation involving the CSF space
Bacterial examples	Neisseria meningitidis, Streptococcus pneumoniae, Listeria monocytogenes, Haemophilus influenzae
Viral examples	Enteroviruses, herpes simplex virus
Tuberculous cause	Mycobacterium tuberculosis
CSF abnormality	Pleocytosis with altered protein and glucose depending on cause
Complications	Raised intracranial pressure, cerebral oedema, vasculitis, infarction
Main investigations	Blood cultures; CSF microscopy, culture, cell count, protein and glucose; PCR; antigen testing
CT before LP	Only when indicated by concern for raised ICP, mass effect or focal intracranial pathology

EXAM TRAPS × tempting option ✓ correct answer

- × Meningitis is solely an organism diagnosis
- ✓ Core pathology is meningeal inflammation, CSF changes and cerebral complications
- × Blood cultures are unnecessary in suspected meningitis
- ✓ Core investigation; bacterial meningitis may be associated with bacteraemia
- × CT head is routine before every lumbar puncture
- ✓ Only when raised ICP, mass effect or focal intracranial pathology is suspected
- × CSF glucose can be interpreted alone
- ✓ Must be compared with concurrent plasma glucose

Gastrointestinal Infections

Gastroenteritis

Viral causes	Norovirus and rotavirus
Bacterial causes	Salmonella, Campylobacter, E. coli including O157:H7, Shigella and C. difficile
Protozoal causes	Giardia lamblia and Cryptosporidium
Core pathology	Mucosal invasion and/or toxin-mediated epithelial damage

Physiological consequence	Fluid and electrolyte depletion causing dehydration and possible acute kidney injury
Key complication	HUS following E. coli O157:H7
Core stool tests	Culture, microscopy for ova/cysts/parasites, C. difficile toxin assay and viral NAAT where indicated

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All infective diarrhoea shares one mechanism
- ✓ Secretory (toxin-mediated) and inflammatory (invasive) diarrhoea have different mechanisms
- × Stool culture alone suffices for persistent diarrhoea
- ✓ Consider protozoa (Giardia, Cryptosporidium); stool microscopy for ova, cysts and parasites
- × Campylobacter is the organism classically linked to HUS
- ✓ E. coli O157:H7, especially after bloody diarrhoea
- × C. difficile organism presence confirms C. difficile infection
- ✓ Toxin-mediated disease requires toxin detection plus compatible diarrhoea and clinical context
- × Gastroenteritis work-up need only identify the organism
- ✓ Check electrolytes and renal function; fluid loss can cause dehydration and AKI

Hepatitis

Core pathology	Hepatocyte inflammation and necrosis
Functional risk	Deranged synthetic, metabolic and excretory liver function
Major acute complication	Fulminant liver failure
Major chronic complication	Fibrosis progressing to cirrhosis
Key viral tests	HAV IgM, HBsAg, anti-HCV
Severity marker	PT / INR as a marker of hepatic synthetic function
Biopsy role	Selected chronic disease assessment rather than routine acute diagnosis

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Very high transaminases best indicate loss of liver synthetic function
- ✓ PT/INR is the key marker of synthetic failure
- × Hepatitis D can cause independent infection
- ✓ Hepatitis D requires hepatitis B surface antigen (HBsAg)
- × Hepatitis is always caused by an infective pathogen
- ✓ Non-infective causes exist, e.g. alcohol causes hepatitis-like liver inflammation
- × Hepatitis A commonly causes chronic hepatitis
- ✓ Hepatitis A is usually acute and self-limited; B and C are the main chronic viral causes

Respiratory Infections

Lower Respiratory Tract Infection and Pneumonia

Typical CAP organisms	S. pneumoniae, H. influenzae, Mycoplasma, Legionella and respiratory viruses.
Typical HAP organisms	Klebsiella, Pseudomonas and other Gram-negative organisms; Staphylococcus aureus.
Pathology	Alveolar inflammation, exudate, consolidation and impaired gas exchange.

Patterns	Lobar pneumonia, bronchopneumonia and atypical/interstitial pneumonia.
Investigation	CXR, sputum culture, blood cultures, blood gas and urinary antigen testing where indicated.

Upper Respiratory Tract Infection (URTI)

Commonest cause group	Viral infection
Key viral causes	Rhinovirus, coronavirus, adenovirus, influenza
Key bacterial cause	Streptococcus pyogenes
Main tissue process	Upper airway mucosal inflammation
Structural effects	Mucosal oedema, increased secretions, impaired mucociliary clearance
Usual investigation	Clinical diagnosis
Targeted tests	Throat swab and rapid antigen testing where indicated

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Exudative sore throat is always bacterial
- ✓ Viral infection can also cause prominent pharyngeal inflammation with exudate
- × Uncomplicated URTI requires routine laboratory testing
- ✓ Diagnosis is clinical; throat swab or rapid antigen testing only where indicated
- × URTI symptoms persist solely due to ongoing infection
- ✓ Impaired mucociliary clearance is a key reason secretions accumulate and symptoms persist

Skin and Soft Tissue Infections

Cellulitis

Main organisms	Streptococcus pyogenes; Staphylococcus aureus including MRSA; Gram-negative organisms in immunocompromised patients
Tissue level	Dermis and subcutaneous tissue
Entry route	Usually through breached skin
Core pathology	Local inflammatory response with oedema, erythema, warmth and tenderness
Major risks	Systemic sepsis, lymphangitis, abscess, necrotising fasciitis
Investigation	Primarily clinical; blood cultures if systemically unwell; wound swab if exudate/entry point; CRP/WCC; ultrasound or MRI if complication suspected

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Cellulitis is an epidermal-only infection
- ✓ Involves the dermis and subcutaneous tissue
- × Cellulitis is diagnosed by inflammatory markers
- ✓ Cellulitis is primarily a clinical diagnosis
- × Swabbing intact skin is useful in cellulitis
- ✓ Swabs help only with exudate, ulceration or a clear entry point
- × Severe pain with rapid progression and toxicity is simple cellulitis
- ✓ Suggests necrotising fasciitis, a different life-threatening soft tissue process

Systemic and Other Infections

AIDS (HIV-AIDS)

Cause	Human immunodeficiency virus
Main target cell	CD4-positive T-lymphocyte
Core pathology	Progressive loss of cell-mediated immunity
Major infection risk	Opportunistic infections, especially in advanced immune suppression
AIDS-defining malignancies	Kaposi's sarcoma, non-Hodgkin's lymphoma and invasive cervical cancer
Core investigations	HIV test, CD4 count, viral load, and site-specific investigation for opportunistic infection

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ HIV infection and AIDS are synonymous
- ✓ AIDS is advanced disease with severe immune deficiency or an AIDS-defining illness
- ✗ HIV is primarily a neutrophil disorder
- ✓ Key pathology is CD4-positive T-cell depletion with failure of cell-mediated immunity
- ✗ A positive HIV test completes the assessment
- ✓ CD4 count and viral load define immune status and activity; further tests guided by suspected opportunistic infection

Fungal Infection

Main organisms	Candida spp., Aspergillus spp., Cryptococcus neoformans, dermatophytes
Superficial disease	Candida mucosal infection and dermatophyte infection of keratinised tissue
Invasive disease	Invasive Candida, Aspergillus and Cryptococcus in susceptible hosts
Important mechanisms	Candida biofilm on lines; Cryptococcus capsule; Aspergillus tissue and vascular invasion
Core investigations	Blood cultures, tissue biopsy/culture, fungal biomarkers, CSF cryptococcal tests, skin/nail scrapings
Core interpretation trap	Fungal growth may represent colonisation; correlate with site, host risk and clinical syndrome

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Any Candida isolate proves invasive candidiasis
- ✓ Source matters: blood is significant; non-sterile sites may reflect colonisation
- ✗ Aspergillus is not linked to neutropenia
- ✓ Aspergillus is particularly associated with neutropenia and invasive tissue disease
- ✗ Dermatophyte infection is a systemic fungal infection
- ✓ Dermatophytes cause superficial infection of keratinised tissue
- ✗ Fungal CNS infection is not a concern in impaired cell-mediated immunity
- ✓ Cryptococcal meningitis is a key fungal CNS infection in these patients

Malaria

Cause	P. falciparum, P. vivax, P. ovale and P. malariae; transmitted by Anopheles mosquito bite.
Most severe species	P. falciparum.

Core pathology	Hepatic phase followed by red cell invasion, red cell lysis, haemolytic anaemia and cytokine-mediated fever.
Falciparum-specific pathology	Cytoadherence and sequestration of infected red cells in cerebral and systemic capillaries.
Key complications	Cerebral malaria, severe anaemia, splenic enlargement, renal impairment, hypoglycaemia, coagulopathy and multiorgan dysfunction.
Gold standard investigation	Serial thick and thin blood films.
Adjunct tests	Malaria RDT and NAAT/PCR.

EXAM TRAPS × tempting option ✓ correct answer

- × A single negative blood film excludes malaria
- ✓ Serial thick and thin films are required while suspicion remains
- × Thin films are more sensitive for detecting malaria
- ✓ Thick films are more sensitive; thin films identify species and parasitaemia
- × Falciparum malaria is severe because of higher fever
- ✓ Cytoadherence and sequestration of infected red cells in capillaries

Pyrexia of Unknown Origin (PUO)

Core concept	Persistent fever without an obvious cause after initial assessment
Infective examples	TB, endocarditis, occult abscess, brucellosis
Non-infective examples	Lymphoma, leukaemia, solid tumours, SLE, adult-onset Still's disease, vasculitis, drugs, factitious fever
Fever mediators	IL-1, IL-6 and TNF acting via hypothalamic prostaglandin E2
Definitive direction	Culture, imaging and tissue sampling where indicated provide the strongest diagnostic evidence

EXAM TRAPS × tempting option ✓ correct answer

- × PUO is synonymous with occult infection
- ✓ Malignancy, connective tissue disease, drug fever and factitious fever are also important cause groups
- × CRP or ESR identifies the source of PUO
- ✓ Inflammatory markers indicate inflammation but not its source
- × Endocarditis in PUO needs no specific investigation beyond a single culture
- ✓ Serial blood cultures and echocardiography when endocarditis is possible
- × Drug fever is excluded by the absence of localising signs
- ✓ Review medications; drug fever mimics infection and may have few localising signs

Urinary and Genitourinary Infections

Pelvic Inflammatory Disease (PID)

- PID is usually polymicrobial; Chlamydia trachomatis and Neisseria gonorrhoeae are the key named pathogens.
- The defining mechanism is ascending infection from the lower genital tract to the uterus, fallopian tubes and ovaries.
- Endometritis and salpingitis explain the main acute pathology.
- Tubo-ovarian abscess and peritonitis are important acute complications.
- Infertility and ectopic pregnancy result from tubal scarring, adhesions and impaired transport.

- Investigations include high vaginal and endocervical swabs, NAAT for chlamydia and gonorrhoea, pelvic ultrasound, inflammatory markers and, rarely acutely, laparoscopy.

Sexually Transmitted Disease (STD)

Main bacterial causes	Neisseria gonorrhoeae, Chlamydia trachomatis, Treponema pallidum
Main viral/protozoal causes	Herpes simplex virus, HIV, Trichomonas vaginalis
Mucosal pattern	Gonorrhoea and chlamydia cause urethritis/cervicitis through mucosal inflammation.
Ulcerative pattern	HSV causes painful vesicles/ulcers; syphilis causes chancre with potential systemic spread.
Key tests	Swabs, NAAT for gonorrhoea/chlamydia, syphilis serology, HIV test with counselling
Public health link	Contact tracing reduces onward transmission and reinfection.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Sexually transmitted infections always cause obvious symptoms
- ✓ Chlamydial infection may be clinically subtle or asymptomatic
- × Gonorrhoea and chlamydia are diagnosed by serology
- ✓ NAAT on an appropriate site-specific sample
- × Syphilis is only a local genital ulcer disease
- ✓ Systemic dissemination is central to its pathology
- × HIV testing is unnecessary when assessing STI risk
- ✓ HIV testing with counselling is a core test in STI assessment

Urinary Tract Infection (UTI)

Most common cause	E. coli
Other causes	Klebsiella, Proteus, Staphylococcus saprophyticus, Enterococcus
Main route	Ascending colonisation from periurethral flora
Key mechanism	Adhesion to uroepithelium via fimbriae, followed by mucosal inflammation
Main complication pathway	Ascending infection to kidney causing pyelonephritis and possible systemic sepsis
Core investigations	Urinalysis, MSSU culture and sensitivity, blood cultures if systemic, renal ultrasound if complicated

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A negative urine nitrite excludes UTI
- ✓ Not all organisms reduce nitrate; urine dwell time also affects the result
- × Fever and flank pain with UTI indicate simple cystitis
- ✓ Suggests ascending infection (pyelonephritis) and possible sepsis
- × Positive urine culture in a catheterised patient confirms infection
- ✓ May be colonisation; interpret with inflammatory and clinical features

Wound Healing

General Principles of Wound Healing

Factors Affecting Wound Healing

Local factors	Problems at the wound site alter contamination, perfusion, tissue apposition and mechanical stability.
Systemic factors	Patient-level disease, nutrition, drugs and oxygen delivery determine how effectively cells can repair tissue.
Most important link	Anything that prolongs inflammation, reduces oxygen delivery or weakens collagen formation delays healing.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Infection delays wound healing only by adding bacteria
- ✓ Key mechanism is prolonged inflammation and damage to new matrix
- × Wound oxygen delivery depends only on perfusion
- ✓ Depends on both perfusion and haemoglobin concentration
- × Corticosteroids aid wound healing by reducing inflammation
- ✓ They delay healing; normal inflammation is needed for debridement and repair signalling
- × Age alone explains poor wound healing in the elderly
- ✓ Age often acts alongside vascular disease, diabetes, anaemia or malnutrition

Phases of Wound Healing

Phase	Core process	Exam phrase to remember
Haemostasis	Platelet plug and fibrin clot	Vasoconstriction + fibrin plug
Inflammatory	Leucocyte recruitment and wound cleaning	Neutrophils and macrophages debride bacteria and necrosis
Proliferative	New matrix, new vessels and surface cover	Fibroblasts + collagen + angiogenesis + epithelialisation
Remodelling	Collagen reorganisation and scar maturation	Crosslinking and tensile strength recovery over months to years

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Wound healing phases are completely separate and sequential
- ✓ Phases overlap, but each has a dominant process
- × Macrophages in wound healing only clear debris
- ✓ They also release mediators that coordinate repair
- × Epithelialisation means the wound is fully healed
- ✓ Surface closure precedes recovery of deep scar tensile strength, which takes months to years

Types of Wound Healing

Primary intention	Clean edges approximated; minimal granulation and minimal scarring.
Secondary intention	Wound left open; heals by granulation tissue, contraction, and epithelialisation; greater scarring.

Tertiary intention	Delayed primary closure; initially left open, then later closed; used in contaminated wounds.
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EXAM TRAPS × tempting option ✓ correct answer

- × Any wound left open heals by tertiary intention
- ✓ Tertiary intention requires later planned (delayed primary) closure; left open alone is secondary intention
- × Secondary intention healing relies on epithelialisation alone
- ✓ Wound contraction is a major reason large open wounds reduce in size
- × Healing by primary intention leaves no scar
- ✓ Minimal scarring, not no scarring

Tissue-Specific Wound Healing

Bone

Healing type	Regeneration with true bone formation
Immediate stage	Haematoma formation: clot scaffold and growth factors
Callus sequence	Soft fibrocartilaginous callus followed by mineralised hard callus
Remodelling	Lamellar bone replaces woven bone; medullary canal and shape are restored
Impairing factors	Infection, poor blood supply, inadequate immobilisation, soft tissue interposition, metabolic disease, smoking, diabetes

EXAM TRAPS × tempting option ✓ correct answer

- × Bone heals by fibrosis like other tissues
- ✓ Bone regenerates true bone tissue, the key exception
- × Soft callus is mineralised bone
- ✓ Soft callus is fibrocartilaginous; hard callus is mineralised bone
- × An active biological response guarantees fracture union
- ✓ Inadequate immobilisation can prevent union despite active biological response

Brain

Neuronal regeneration	Absent in destroyed mature neurons.
Main healing pattern	Glial scarring through astrocyte proliferation, also called gliosis.
Debridement	Macrophages and microglia clear necrotic tissue.
Large lesions	May leave cavities or cystic change.
Plasticity	Limited recovery through axonal sprouting and synaptic reorganisation in surviving tissue.
Clinical implication	Deficits after stroke, trauma or infection may be permanent; rehabilitation uses residual plasticity.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Destroyed neurons are replaced by new functional neurons
- ✓ No true regeneration; healing is by gliosis
- ✗ Brain scarring is collagen scar formed by fibroblasts
- ✓ Gliosis is astrocyte-driven glial scarring
- ✗ Recovery after brain injury reflects regrowth of dead neurons
- ✓ Resolution of reversible factors and neural plasticity (axonal sprouting, synaptic reorganisation)

Myocardial (Cardiac Muscle)

Regenerative capacity	Very limited
Main healing pattern	Fibrosis and scar formation
Infarcted tissue	Irreversible myocyte necrosis
Debridement	Inflammatory response and macrophage clearance of necrotic tissue
Repair tissue	Granulation tissue with fibroblast infiltration
Final repair	Collagen scar replacing functional myocardium
Functional implication	Permanent loss of function in the infarcted area
Compensation	Surrounding myocardium may hypertrophy

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Myocardial healing after infarction restores normal muscle
- ✓ Infarcted area is replaced by non-contractile collagen scar
- ✗ Myocardial fibrosis restores contractile function
- ✓ Fibrosis stabilises the wall but cannot restore contraction
- ✗ The infarcted wall is strongest early after infarction
- ✓ Rupture risk is early, before mature collagen scar has formed

Peripheral Nerve

Main repair mechanism	Wallerian degeneration followed by axonal regrowth from the proximal stump.
Distal segment	Degenerates because it is disconnected from the neuronal cell body.
Schwann-cell role	Proliferate and form bands of Büngner to guide regrowth.
Regrowth rate	Approximately 1 mm per day.
Recovery depends on	Degree of injury, gap size, age and distance from the end organ.
Complete division	No functional recovery if the nerve is completely divided and left unrepaired.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Peripheral nerve axons regrow rapidly, around 1 cm per day
- ✓ Approximately 1 mm per day
- ✗ Peripheral nerve repair achieves full tissue restoration
- ✓ Regeneration is limited and depends on preserved or repaired guide structures (Schwann cell bands of Büngner)
- ✗ An unrepaired completely divided nerve recovers function with time
- ✓ No functional recovery without repair

Skin

Epidermis	Regenerates by keratinocyte migration from wound edges and hair follicles.
Dermis	Repairs by fibrosis and scar formation.
Appendages	Hair follicles and sebaceous glands are not regenerated once destroyed.
Abnormal scar risk	Hypertrophic scarring and keloid formation.
Key local factors	Wound tension, infection and skin blood supply.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × All skin layers heal by regeneration
- ✓ Epidermis regenerates; dermis heals mainly by fibrosis
- × Hypertrophic scars extend beyond the original wound margin
- ✓ Keloids extend beyond the wound margin; hypertrophic scars stay within it

Tendon

Mode of healing	Fibrosis and functional repair, not true regeneration.
Intrinsic healing	Repair from tenocytes within the tendon.
Extrinsic healing	Repair from surrounding tissue; important cause of adhesions.
Early collagen	Type III collagen, relatively weak.
Later collagen	Type I collagen, stronger after remodelling.
Main functional risk	Adhesions impair tendon gliding.

PATHOLOGY · TOPIC 5 OF 5

Haematology

Anaemia

Causes of Anaemia

Cause	Core mechanism	Classic causes or associations
Iron deficiency	Reduced haem synthesis	GI blood loss, menstrual blood loss, malabsorption, pregnancy
Vitamin B12 deficiency	Defective DNA synthesis	Pernicious anaemia, malabsorption, strict vegan diet, gastrectomy
Folate deficiency	Defective DNA synthesis	Poor intake, malabsorption, pregnancy, methotrexate, phenytoin
Haemolytic anaemia	Increased red cell destruction	Hereditary spherocytosis, sickle cell disease, autoimmune, mechanical, infection
Anaemia of chronic disease	Cytokine-mediated suppression and impaired iron use	Chronic inflammation, infection or malignancy

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ All microcytic anaemia is iron deficiency
- ✓ Anaemia of chronic disease can sometimes be microcytic
- ✗ Folate deficiency causes neurological features like B12 deficiency
- ✓ Both macrocytic and megaloblastic, but neurological features suggest B12 deficiency
- ✗ Chronic blood loss typically causes macrocytic anaemia
- ✓ Causes iron deficiency anaemia as iron stores are gradually depleted
- ✗ Anaemia of chronic disease is dietary iron deficiency
- ✓ Cytokine-mediated impairment of iron utilisation and erythropoiesis

Classification of Anaemia

By size	Microcytic, normocytic or macrocytic according to MCV.
By production	Iron deficiency, B12/folate deficiency, marrow failure and anaemia of chronic disease reduce effective red cell production.
By destruction	Haemolytic anaemias include hereditary spherocytosis, G6PD deficiency, sickle cell disease, autoimmune haemolysis and TTP/HUS.
By loss	Blood loss may be acute or chronic; chronic loss commonly produces iron deficiency.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Normocytic anaemia indicates a benign process
- ✓ Acute blood loss, haemolysis, renal failure and marrow failure may all be normocytic
- ✗ Anaemia of chronic disease is always normocytic
- ✓ Classically normocytic, but may be microcytic
- ✗ Macrocytosis indicates B12 deficiency
- ✓ Also folate deficiency, alcohol, liver disease, hypothyroidism and drugs
- ✗ MCV establishes the final cause of anaemia
- ✓ MCV classifies the pattern; mechanism and investigations identify the cause

Investigation of Anaemia

FBC	Confirms anaemia and provides Hb, MCV, MCH, MCHC and reticulocyte count.
Blood film	Identifies red cell morphology: target cells, spherocytes, sickle cells and fragments.
Iron studies	Assess iron availability using serum iron, ferritin, transferrin saturation and TIBC.
Vitamin B12 and folate	Investigate megaloblastic macrocytic anaemia.
Reticulocyte count	Separates hypoproliferative anaemia from haemolysis or blood loss.
DAT / Coombs test	Supports autoimmune haemolytic anaemia.
Bone marrow biopsy	Investigates aplastic anaemia and bone marrow infiltration.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × MCV alone proves the cause of anaemia
- ✓ MCV classifies anaemia but does not prove the cause
- × A normal MCV excludes haematinic deficiency
- ✓ Mixed deficiencies can give normal MCV; check B12, folate and iron
- × A raised reticulocyte count indicates primary marrow failure
- ✓ Points towards haemolysis or blood loss
- × Bone marrow biopsy is a screening test for all anaemia
- ✓ Targeted to suspected marrow failure (e.g. aplastic anaemia) or infiltration

Coagulation

Acquired Coagulation Disorders

DIC mechanism	Widespread coagulation activation with consumption of platelets, clotting factors and fibrinogen
DIC causes	Sepsis, trauma, obstetric emergencies, malignancy, burns and transfusion reactions
DIC blood film	Schistocytes from microangiopathic haemolysis
Liver disease mechanism	Reduced synthesis of clotting factors II, VII, IX, X and fibrinogen; reduced protein C and S; hypersplenism
Vitamin K-dependent factors	II, VII, IX and X
Vitamin K deficiency tests	Predominantly prolonged PT; APTT may prolong in severe deficiency

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × DIC is purely a bleeding disorder
- ✓ Thrombosis and organ dysfunction are central to DIC pathology
- × Fibrinogen is typically raised in DIC
- ✓ Low, because it is consumed
- × A prolonged PT is specific to warfarin
- ✓ Also a sensitive marker of liver synthetic dysfunction and vitamin K deficiency
- × Platelet disorders typically cause haemarthrosis and muscle haematomas
- ✓ Platelet disorders cause mucocutaneous bleeding; coagulation factor disorders cause deep bleeding

Inherited Coagulation Disorders

Haemophilia A	Factor VIII deficiency; X-linked recessive; prolonged APTT, normal PT
Haemophilia B	Factor IX deficiency; X-linked recessive; prolonged APTT, normal PT
Shared haemophilia bleeding pattern	Haemarthrosis, deep muscle haematomas, prolonged bleeding after trauma or surgery
Von Willebrand disease	Most common inherited bleeding disorder; vWF deficiency or dysfunction
vWF functions	Platelet adhesion and Factor VIII stabilisation
vWD clinical pattern	Mucocutaneous bleeding; haemarthrosis less common than haemophilia
vWD investigations	Prolonged bleeding time; APTT may be prolonged (low factor VIII); low vWF antigen and activity

EXAM TRAPS × tempting option ✓ correct answer

- × Haemophilia A and B are clinically distinguishable
- ✓ Clinically identical; differ by Factor VIII (A) versus Factor IX (B) deficiency
- × Haemophilia prolongs the PT
- ✓ Prolonged APTT with normal PT
- × Von Willebrand disease is a pure platelet disorder
- ✓ Affects platelet adhesion and Factor VIII stability; bleeding time and APTT may both be abnormal
- × Petechiae are typical of isolated haemophilia
- ✓ Petechiae point to platelet number or function problems

Platelet Disorders

Reduced platelet count	Thrombocytopaenia
Production failure causes	Bone marrow failure, leukaemia, aplastic anaemia, drugs, alcohol, B12/folate deficiency
Destruction/consumption causes	ITP, TTP, HUS, DIC, HIT
Sequestration cause	Hypersplenism
Inherited dysfunction	Bernard-Soulier syndrome; Glanzmann's thrombasthenia
Acquired dysfunction	Aspirin/NSAIDs, uraemia, liver disease
Bleeding pattern	Petechiae, purpura, epistaxis, gum bleeding, prolonged bleeding time

EXAM TRAPS × tempting option ✓ correct answer

- × A normal platelet count excludes a platelet disorder
- ✓ Platelet dysfunction can occur with a normal count
- × Platelet disorders classically cause haemarthrosis and deep haematomas
- ✓ Platelet disorders cause petechiae and mucosal bleeding; severe factor deficiencies cause haemarthrosis
- × The main danger in HIT is bleeding from thrombocytopaenia
- ✓ HIT is prothrombotic; thrombosis is the major danger despite falling platelets

Thrombophilia

Definition	Inherited or acquired tendency towards pathological thrombosis.
Most common inherited thrombophilia	Factor V Leiden mutation.
Factor V Leiden mechanism	Resistance to activated protein C.
Prothrombin mutation	G20210A mutation causing elevated prothrombin levels.
Protein C / protein S deficiency	Impaired anticoagulant pathway; reduced inactivation of Factors Va and VIIIa.
Antithrombin deficiency	Reduced inhibition of thrombin and Factor Xa.
Antiphospholipid syndrome	Lupus anticoagulant and anticardiolipin antibodies; recurrent venous/arterial thrombosis and pregnancy loss.
Other acquired risks	Malignancy, immobility, pregnancy, combined oral contraceptive pill and obesity.
Investigation timing	Test away from acute thrombosis and off anticoagulation where possible.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ Lupus anticoagulant (antiphospholipid syndrome) causes a bleeding tendency
- ✓ Antiphospholipid syndrome is prothrombotic in vivo despite the name 'lupus anticoagulant'
- ✗ Low protein C, S or antithrombin during acute thrombosis confirms inherited deficiency
- ✓ Interpret with caution: acute thrombosis and anticoagulation lower levels; test away from the acute event and off anticoagulation
- ✗ Inherited thrombophilias mainly predispose to arterial disease
- ✓ Most inherited thrombophilias primarily predispose to venous thromboembolism
- ✗ Thrombophilia is essentially an inherited condition
- ✓ Acquired prothrombotic states are common: malignancy, immobility, pregnancy, combined oral contraceptive pill and obesity

Leukaemia

Acute Lymphoblastic Leukaemia (ALL)

Disease type	Acute lymphoid leukaemia
Cell involved	Immature lymphoid precursor: lymphoblast
Classic age association	Childhood; peak approximately 2-5 years
Pathological basis	Clonal lymphoblast proliferation in bone marrow
Main consequence	Bone marrow failure
Clinical pattern	Anaemia, thrombocytopaenia, neutropaenia, bone pain, lymphadenopathy, hepatosplenomegaly, CNS involvement
Key investigations	FBC, blood film, bone marrow biopsy, immunophenotyping, cytogenetics

⚠ EXAM TRAPS × tempting option ✓ correct answer

- ✗ A raised white cell count in ALL indicates intact immune function
- ✓ Circulating cells may be malignant blasts that are functionally ineffective
- ✗ Anaemia is the only important cytopenia from marrow failure in ALL
- ✓ Thrombocytopaenia and neutropaenia also occur; bleeding and infection are core consequences
- ✗ FBC alone gives a definitive diagnosis of ALL
- ✓ Bone marrow assessment and immunophenotyping are required to characterise the disease

Acute Myeloid Leukaemia (AML)

Disease type	Acute myeloid leukaemia
Typical patient group	Adults; median age about 65 years
Pathological basis	Clonal proliferation of immature myeloid precursors
Main mechanism of illness	Bone marrow failure and accumulation of non-functional blasts
Clinical features	Anaemia, bleeding, severe infections, DIC in AML-M3, gum hypertrophy, skin infiltration
FBC / film	Raised white cell count with blasts or pancytopenia; Auer rods may be present
Definitive investigation	Bone marrow biopsy with specialist testing
Additional tests	Cytogenetics and coagulation screen

EXAM TRAPS × tempting option ✓ correct answer

- ✗ CML is blast-driven and AML shows a spectrum of mature myeloid cells
- ✓ AML is acute and blast-driven; CML is chronic with a spectrum of mature myeloid cells
- ✗ A raised white cell count in AML means effective immunity
- ✓ AML blasts are non-functional and neutropaenia may be severe
- ✗ DIC is not a typical feature of acute promyelocytic leukaemia
- ✓ DIC is characteristic of acute promyelocytic leukaemia (AML-M3)
- ✗ Auer rods point towards ALL
- ✓ Auer rods point towards AML rather than ALL

Chronic Lymphocytic Leukaemia (CLL)

Disease type	Chronic lymphoid leukaemia
Typical patient group	Adults over 60 years
Common discovery	Incidental lymphocytosis on FBC
Cell involved	Mature but non-functional B-lymphocyte
Pathological consequences	Bone marrow infiltration and immune dysfunction
Clinical features	Asymptomatic early; lymphadenopathy, splenomegaly, recurrent infections, anaemia, autoimmune haemolytic anaemia
Investigations	FBC, blood film, immunophenotyping, bone marrow biopsy
Characteristic blood film clue	Smear cells

EXAM TRAPS × tempting option ✓ correct answer

- ✗ CLL involves lymphoblasts and is a childhood malignancy
- ✓ CLL: mature B-lymphocytes, older adults; ALL: lymphoblasts, classically childhood
- ✗ Lymphocytosis in CLL indicates good immune function
- ✓ CLL lymphocytes are functionally abnormal, causing immune dysfunction
- ✗ Anaemia in CLL is always due to marrow infiltration
- ✓ Autoimmune haemolytic anaemia is an important cause of anaemia in CLL

Chronic Myeloid Leukaemia (CML)

Disease type	Chronic myeloid leukaemia / myeloproliferative neoplasm.
Main abnormality	BCR-ABL fusion gene.
Chromosome change	Philadelphia chromosome: t(9;22).
Pathological process	Clonal expansion of mature myeloid cells.
Clinical features	Splenomegaly, fatigue, weight loss, night sweats.
Transformation risk	Blast crisis with AML/ALL-like presentation.
Investigations	FBC, blood film, bone marrow biopsy, cytogenetics, BCR-ABL PCR.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ CML blood film is dominated by blasts
- ✓ CML shows all myeloid stages in the blood; blast domination indicates AML
- ✗ Blast crisis is a separate chronic leukaemia
- ✓ Blast crisis is transformation of CML into an acute leukaemia-like phase

Classification of Leukaemia

Category	Meaning	Main examples
Acute lymphoid	Immature lymphoid blasts	ALL
Chronic lymphoid	Mature-appearing lymphoid cells	CLL
Acute myeloid	Immature myeloid blasts	AML
Chronic myeloid	Mature myeloid cell expansion	CML

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × 'Acute' and 'chronic' describe the cell lineage of leukaemia
- ✓ They describe disease tempo and cell maturity; lineage is lymphoid or myeloid
- × All lymphoid leukaemias are acute
- ✓ CLL is a chronic lymphoid leukaemia
- × All myeloid leukaemias are chronic
- ✓ AML is an acute myeloid leukaemia

Lymphoma and Myeloma

Lymphoma

Classification	Hodgkin lymphoma vs non-Hodgkin lymphoma.
Hodgkin lymphoma	Reed-Sternberg cells; bimodal age distribution.
Non-Hodgkin lymphoma	Heterogeneous group; B-cell types most common, T-cell types also occur.
Core presentation	Painless lymphadenopathy with possible B symptoms.
Systemic features	Fever, night sweats, weight loss >10% body weight.
Organ involvement	Splenomegaly, hepatomegaly, bone marrow, CNS, and gastrointestinal tract.
Definitive diagnosis	Lymph node biopsy.
Staging and assessment	CT chest/abdomen/pelvis, PET-CT, FBC, LDH, bone marrow biopsy.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Lymphoma can be definitively diagnosed on imaging (CT/PET-CT)
- ✓ Tissue (lymph node) biopsy is required for definitive diagnosis
- × Reed-Sternberg cells indicate non-Hodgkin lymphoma
- ✓ Reed-Sternberg cells point towards Hodgkin lymphoma
- × B symptoms include local compressive symptoms of lymphadenopathy
- ✓ B symptoms are fever, night sweats and weight loss >10% body weight
- × Non-Hodgkin lymphoma is a single disease entity
- ✓ It includes multiple B-cell and T-cell malignancies

Myeloma (Multiple Myeloma)

Cell of origin	Malignant plasma cell.
Main site of disease	Bone marrow.
Secreted product	Monoclonal immunoglobulin/paraprotein; IgG most common. Free light chains may be produced.

Mnemonic	CRAB: hyperCalcaemia, Renal impairment, Anaemia, Bone disease.
Bone pathology	Osteolytic lesions caused by increased bone resorption.
Renal pathology	Light-chain deposition/toxicity, often with Bence Jones proteinuria.
Definitive tissue assessment	Bone marrow biopsy showing clonal plasma-cell infiltration; plasma cells >10% supports diagnosis.

 EXAM TRAPS × tempting option ✓ correct answer

- × Myeloma is a type of lymphoma centred on lymph nodes
- ✓ Myeloma is a plasma-cell malignancy centred on bone marrow with paraprotein production
- × Bone lesions in myeloma are osteoblastic
- ✓ Myeloma bone lesions are osteolytic, from increased bone resorption
- × Renal impairment in myeloma requires a large paraprotein burden
- ✓ Light chains can cause renal impairment even when paraprotein burden appears modest
- × A normal plain skeletal survey excludes myeloma bone disease
- ✓ It does not; whole-body MRI or PET-CT is more sensitive

NOW TEST IT

Reading Pathology is not the same as answering it under time pressure.

Pathology questions reward precise distinctions: CLL versus ALL, anaphylaxis versus anaphylactoid. Check yours with MCQs that explain every option.

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CHAPTER 6

Evidence-Based Medicine

4 curriculum topics · 46 subtopics · 158 exam traps

Principles of Evidence-Based Medicine · Study Design and Methodology · Statistics in Medical Practice · Critical Appraisal

EVIDENCE-BASED MEDICINE · TOPIC 1 OF 4

Principles of Evidence-Based Medicine

Definition of Evidence-Based Medicine

Core Definition

Core definition	Conscientious, explicit and judicious use of current best evidence for decisions about individual patient care
Evidence pillar	Best available research evidence
Expertise pillar	Clinical expertise of the practitioner
Patient pillar	Patient values and preferences
Key principle	All three pillars must be integrated; evidence alone is not sufficient

 **EXAM TRAPS** × tempting option ✓ correct answer

- × EBM means using research evidence alone
- ✓ EBM integrates best research evidence, clinician expertise and patient values
- × A statistically supported intervention must always be used
- ✓ Evidence must still be applied to the individual patient
- × EBM uses any published evidence
- ✓ EBM uses current best evidence

Hierarchy of Evidence

Top of hierarchy	Systematic reviews and meta-analyses
Highest primary study design for interventions	Randomised controlled trial
Middle observational designs	Cohort, case-control, and cross-sectional studies
Low-level descriptive evidence	Case reports and case series
Lowest level	Expert opinion and editorials
Key caution	Higher-level evidence is more reliable in general, but not always available or appropriate for every clinical question

 **EXAM TRAPS** × tempting option ✓ correct answer

- × The evidence hierarchy is absolute; design alone determines reliability
- ✓ Study design matters, but validity and applicability still need appraisal
- × Individual RCTs sit at the top of the evidence hierarchy

- ✓ Systematic reviews and meta-analyses sit above individual RCTs
- ✗ Case-control studies rank above cohort studies
- ✓ Cohort studies usually sit higher than case-control studies in the standard hierarchy
- ✗ Expert opinion is equivalent to research evidence
- ✓ Expert opinion is the lowest level in the hierarchy
- ✗ Lower-level evidence should always be rejected
- ✓ It may be the best available evidence for rare, impractical or ethically difficult questions

The EBM Process

Core process	Ask, Acquire, Appraise, Apply, Assess
Ask	Formulate a structured clinical question
Acquire	Search for the best available evidence
Appraise	Evaluate validity and relevance
Apply	Integrate evidence with clinical expertise and patient values
Assess	Evaluate the outcome of the decision
PICO	Patient / Population / Problem, Intervention, Comparison, Outcome

⚠ EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ PICO is the whole EBM process
- ✓ PICO belongs to the Ask step; the process is Ask, Acquire, Appraise, Apply, Assess
- ✗ Evidence can be used once a relevant paper is found
- ✓ Evidence must be appraised before use in patient care
- ✗ The EBM process ends at critical appraisal
- ✓ It continues to Apply to the individual patient and Assess the outcome
- ✗ The Apply step uses research evidence alone
- ✓ Apply integrates evidence with clinical expertise and patient values

EVIDENCE-BASED MEDICINE · TOPIC 2 OF 4

Study Design and Methodology

Randomised Controlled Trial (RCT)

Advantages of RCTs

Randomisation	Minimises selection bias and helps balance confounding factors between groups.
Blinding	Minimises performance bias and detection bias by keeping allocation unknown to relevant people.
Causal inference	Provides the best primary design for testing whether an intervention causes an outcome.
Therapeutic evidence	Gives high-quality evidence for treatment effects, below systematic review/meta-analysis in the hierarchy.
Effect measures	Allows calculation of relative risk, absolute risk reduction, and number needed to treat.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ An RCT sits above a systematic review/meta-analysis in the hierarchy
- ✓ RCT is the highest primary design for interventions, below systematic review/meta-analysis
- ✗ Randomisation reduces performance and detection bias
- ✓ Randomisation reduces selection bias and confounding; blinding reduces performance and detection bias
- ✗ Odds ratio is the main outcome measure of an RCT
- ✓ RCTs commonly allow calculation of relative risk, ARR and NNT

Design

Core design	Random allocation to intervention or control group.
Baseline comparability	Randomisation aims to make groups similar before treatment starts.
Control group	May receive placebo control or active comparator.
Single-blind	Participant unaware.
Double-blind	Participant and investigator unaware.
Triple-blind	Participant, investigator, and outcome assessor unaware.
Crossover RCT	Participants receive both interventions in sequence, with a washout period.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ Randomisation and blinding are the same process
- ✓ Randomisation determines allocation; blinding keeps people unaware of the allocated treatment afterwards
- ✗ A crossover RCT is any trial with two arms
- ✓ Same participants receive both interventions sequentially, separated by a washout period

Disadvantages of RCTs

Cost and time	RCTs are expensive and time-consuming to conduct.
Ethics	Patients cannot be randomised to known harmful exposures or clearly inferior care.
Volunteer bias	Trial participants may not represent real-world patients.
Short follow-up	Late benefits, harms, or long-term outcomes may be missed.
Rare outcomes	Very large samples are needed; otherwise the trial may be underpowered.
Generalisability	Highly controlled conditions may limit external validity or applicability.
Dropouts	Intention-to-treat analysis is needed to reduce bias after withdrawals or non-adherence.

EXAM TRAPS × tempting option ✓ correct answer

- ✗ An RCT is always an ethical option
- ✓ Harmful exposures cannot be deliberately assigned
- ✗ Randomisation guarantees real-world applicability
- ✓ External validity may still be limited by highly controlled conditions
- ✗ Dropouts can be excluded from RCT analysis without bias
- ✓ Intention-to-treat analysis preserves the benefits of randomisation
- ✗ An RCT is the best design for rare outcomes
- ✓ Rare outcomes need very large samples; otherwise the RCT is underpowered

Cohort Study

Advantages of Cohort Studies

Best recognised advantage	Exposure precedes outcome, allowing temporal sequence to be assessed.
Multiple outcomes	Several outcomes can be studied from one exposure-defined cohort.
Most suitable outcome frequency	Common outcomes.
Bias comparison	Less recall bias than case-control studies.
Prospective cohort strength	Exposure data are collected before outcome status is known.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Cohort studies prove causation because exposure precedes outcome
- ✓ Temporal sequence is shown, but cohort studies are observational, not randomised
- × Odds ratio is the usual measure in cohort studies
- ✓ Relative risk is the usual cohort measure
- × Cohort studies are more prone to recall bias than case-control studies
- ✓ Cohort studies are less susceptible to recall bias, especially when prospective

Design

Starting point	Exposure status.
Comparison groups	Exposed versus unexposed.
Time sequence	Exposure precedes outcome.
Prospective design	Exposure recorded now; outcomes measured in future follow-up.
Retrospective design	Existing records identify past exposure and later outcomes.
Main measure	Relative risk (RR).

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A retrospective cohort study is a case-control study
- ✓ Cohort is organised by exposure status; case-control by outcome status
- × Odds ratio is the characteristic measure for cohort studies
- ✓ Relative risk, because outcome risk can be calculated in exposed and unexposed groups
- × In a cohort study the researcher randomises participants to exposure
- ✓ Exposure is observed, not randomised; that would be an RCT

Disadvantages of Cohort Studies

Confounding	Unmeasured factors may affect both exposure and outcome.
Rare outcomes	Require very large cohorts to observe enough events.
Prospective cohort burden	Often expensive and time-consuming because participants are followed over time.
Loss to follow-up	May cause attrition bias if missing participants differ from those retained.
Causality	Less convincing than an RCT because there is no randomisation.

EXAM TRAPS × tempting option ✓ correct answer

- × Cohort studies prove causation
- ✓ They are observational and remain vulnerable to confounding
- × A cohort study is the most efficient design for a rare outcome
- ✓ Case-control studies are usually more efficient for rare outcomes
- × Loss to follow-up does not bias cohort results
- ✓ Incomplete follow-up can cause attrition bias

Case-Control Study

Advantages of Case-Control Studies

Best suited to	Rare outcomes or diseases.
Speed and cost	Often quicker and less expensive than cohort studies.
Exposure analysis	Can examine multiple exposures simultaneously.
Latency	Useful when disease develops long after exposure.
Key contrast	Cohort studies are strong for multiple outcomes from one exposure; case-control studies are strong for multiple exposures linked to one outcome.

EXAM TRAPS × tempting option ✓ correct answer

- × Case-control studies are best for rare exposures
- ✓ They are classically used for rare outcomes or diseases
- × Case-control studies establish causality as confidently as RCTs
- ✓ Being efficient does not give RCT-level confidence in causality

Design

Start point	Outcome status.
Groups	Cases with the condition; controls without the condition.
Direction	Backwards to previous exposure.
Comparison	Exposure history in cases versus controls.
Measure	Odds ratio.

EXAM TRAPS × tempting option ✓ correct answer

- × Case-control participants are selected by exposure status
- ✓ Selected by outcome status; selection by exposure defines a cohort study
- × Case-control studies follow participants forward from exposure to outcome
- ✓ They look backwards from outcome to previous exposure
- × Relative risk is the main measure of a case-control study
- ✓ The odds ratio is the expected measure

Disadvantages of Case-Control Studies

Information bias	Recall bias: cases may remember previous exposures differently from controls.
Control selection	Controls must be appropriate; poor selection introduces selection bias.
Risk measurement	Incidence and relative risk are not directly calculated.

Main association measure	Odds ratio.
Timing	Exposure-outcome sequence can be difficult to confirm.
Confounding	Difficult to control retrospectively if confounders were not measured well.

EXAM TRAPS × tempting option ✓ correct answer

- × Case-control studies directly calculate relative risk
- ✓ They usually report an odds ratio
- × Case-control studies measure incidence
- ✓ Incidence cannot be measured; numbers of cases and controls are set by the researcher
- × Recall bias is classically associated with cohort studies
- ✓ Recall bias is classic for case-control studies, which ask about past exposure
- × Choice of controls has little effect on case-control validity
- ✓ Inappropriate controls introduce selection bias and can invalidate the comparison

Cross-Sectional Study

Advantages of Cross-Sectional Studies

Advantage	Why it matters	Exam implication
Quick and inexpensive	Participants are assessed once, without prolonged follow-up.	Best answer when the stem asks for a rapid, low-resource way to measure a population at one point in time.
Good for prevalence	Measures how common a condition, exposure, or risk factor is in a defined population.	Think cross-sectional when the question asks, "How common is this now?"
Useful for public health planning	Prevalence data help estimate burden of disease and plan services or prevention strategies.	Useful for surveys, service planning, and identifying health needs.
Generates hypotheses	Observed associations can suggest areas for further analytic research.	It can suggest a possible association, but further study is needed to test it robustly.
Multiple variables measured together	Several exposures and outcomes can be recorded at the same assessment.	A single study can examine several risk factors and outcomes simultaneously.

EXAM TRAPS × tempting option ✓ correct answer

- × The classic advantage of a cross-sectional study is measuring incidence
- ✓ It is prevalence estimation
- × Measuring many exposures and outcomes lets cross-sectional studies prove causality
- ✓ They mainly identify patterns and associations

Design

Study type	Observational study
Timing	Exposure and outcome measured at a single point in time
Alternative names	Prevalence study; survey
Main measure	Prevalence
Association measure	Can generate odds ratios
Key exam clue	One-off assessment of a defined population

EXAM TRAPS × tempting option ✓ correct answer

- × A one-off population assessment is a cohort study
- ✓ Cohort requires follow-up over time from exposure to later outcome; single time point is cross-sectional
- × Comparing affected and unaffected groups makes it a case-control study
- ✓ Group comparison at a single time point is still cross-sectional
- × A cross-sectional odds ratio shows exposure preceded outcome
- ✓ It does not establish temporal sequence

Disadvantages of Cross-Sectional Studies

Disadvantage	Why it matters	Exam implication
No temporal relationship	Exposure and outcome are measured at the same time, so the sequence is unclear.	Do not choose cross-sectional study as the best design when the question requires proof that exposure preceded outcome.
Cannot establish causality	Associations may be seen, but cause and effect cannot be proven.	An association from a cross-sectional survey should be interpreted cautiously.
Prevalence-incidence bias	Existing survivors are over-represented, while rapidly fatal or short-duration cases may be missed.	Be alert when a study samples only current cases at one point in time.
Non-response bias	Responders may differ systematically from non-responders.	Low or selective response rates threaten representativeness and external validity.

EXAM TRAPS × tempting option ✓ correct answer

- × A cross-sectional association proves exposure caused the outcome
- ✓ It shows association only; causality cannot be proven
- × A single-time-point study establishes temporal sequence
- ✓ Measurement at a single point in time leaves temporality unclear
- × Prevalence-incidence bias over-represents rapidly fatal cases
- ✓ Sampling current cases over-represents survivors; rapidly fatal or short cases are missed

Systematic Review and Meta-Analysis

Advantages of Systematic Reviews and Meta-Analyses

Advantage	Meaning	Why it matters
Highest level of evidence	Synthesises the available evidence on a defined question.	Gives a broader and more reliable overview than a single study.
Reduces impact of small underpowered studies	Individual small studies are less likely to dominate the conclusion.	Helps avoid over-interpreting one imprecise or inconclusive result.
Reduces random error through pooling	Meta-analysis combines numerical results when pooling is appropriate.	Can increase power and improve precision of the effect estimate.
Transparent and reproducible methodology	Search, selection, appraisal, and synthesis methods are explicit.	Makes the review easier to check, repeat, and critically appraise.

EXAM TRAPS × tempting option ✓ correct answer

- × One small trial outweighs a well-conducted systematic review
- ✓ A well-conducted systematic review of the relevant evidence is stronger
- × Transparent methods guarantee a review's conclusions are valid
- ✓ Transparency makes appraisal easier; study quality must still be judged
- × Meta-analysis pools by adding up study conclusions
- ✓ It combines numerical effect estimates to reduce random error and improve precision

Disadvantages of Systematic Reviews and Meta-Analyses

Disadvantage	Meaning	Why it matters
Garbage in, garbage out	The review is limited by the quality of the included primary studies.	A pooled estimate may be misleading if based on biased or weak studies.
Heterogeneity	Included studies may differ substantially from each other.	Pooling may be inappropriate if the studies are too different.
Publication bias	Positive studies are more likely to be published than negative or null studies.	The pooled result may overestimate the true effect.
Time and resource burden	A rigorous review requires searching, screening, appraisal, extraction, and synthesis.	High-quality reviews need expertise, time, and careful methodology.

EXAM TRAPS × tempting option ✓ correct answer

- × A meta-analysis is reliable simply because it is high in the hierarchy
- ✓ It is limited by included study quality (garbage in, garbage out)
- × Heterogeneity does not affect the validity of a pooled result
- ✓ Pooling may be misleading or inappropriate if studies are too different
- × Absence of published negative studies means no negative evidence exists
- ✓ Publication bias: negative or null studies are less likely to be published

Meta-Analysis

Definition	Quantitative statistical pooling of data from multiple studies.
Main output	A pooled overall effect estimate.
Main benefit within this design	Increases statistical power and precision.
Forest plot box	Individual study estimate; box size reflects study weight.
Forest plot line	Horizontal line shows the 95% confidence interval.
Forest plot diamond	Pooled effect estimate; crossing the no-effect line means not statistically significant.
Line of no effect	1.0 for ratios; 0 for differences.
I-squared	Assesses heterogeneity between studies.
Funnel plot	Assesses publication bias; asymmetry suggests possible bias.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Systematic review and meta-analysis are the same thing
- ✓ Systematic review is the structured process; meta-analysis is the quantitative pooling step
- × The line of no effect for ratios is 0
- ✓ For odds, risk and hazard ratios it is 1.0; 0 is for differences
- × A high I-squared is a strength of a meta-analysis
- ✓ High I-squared indicates substantial heterogeneity, making pooling questionable
- × An asymmetric funnel plot proves the treatment is ineffective
- ✓ It suggests publication bias

Systematic Review

Feature	Meaning	Why it matters
Defined clinical question	The review addresses a specific question rather than a broad, informal topic.	Keeps the review focused and determines which evidence is relevant.
Comprehensive search	The authors attempt to identify all relevant available evidence.	Reduces the risk of conclusions being based on a selective sample of studies.
Predefined criteria	Inclusion and exclusion criteria are set before study selection.	Makes study selection more transparent and less prone to author preference.
Quality assessment	Included studies are appraised for validity and risk of bias.	Prevents weak studies from being treated as equally reliable as stronger studies.
Transparent methods	The search, selection, and appraisal process is reported clearly.	Allows readers to judge and potentially reproduce the process.
Qualitative synthesis	Findings are summarised descriptively, including consistency and quality of evidence.	A systematic review does not have to include numerical pooling to be useful.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A systematic review is the same as a narrative review
- ✓ Systematic uses explicit predefined methods; narrative is informal and prone to selection bias
- × Every systematic review contains a meta-analysis
- ✓ Meta-analysis is performed only when numerical pooling is appropriate
- × Quality assessment is optional in a systematic review
- ✓ Validity and risk of bias of included studies should be assessed

Other Study Designs

Case Reports and Case Series

Case report	Description of one patient with a condition or clinically noteworthy finding.
Case series	Description of a small number of patients with a similar condition, presentation, exposure, or outcome.
Useful for	Rare conditions, novel presentations, adverse drug reactions, and hypothesis generation.
Advantages	Simple, inexpensive, and able to identify new phenomena.
Disadvantages	No control group; cannot establish causality; highly susceptible to bias.
Evidence level	Lowest level of primary evidence.

EXAM TRAPS × tempting option ✓ correct answer

- × Case reports and series provide evidence of causation
- ✓ They can only suggest a possible association
- × Case series include a control group
- ✓ Case reports and series have no control group
- × Case series rank above cohort or case-control studies
- ✓ They rank below analytical observational studies; lowest level of primary evidence

Ecological Study

What is compared?	Group-level exposures and group-level outcomes
What is the unit of analysis?	The population or group
What is it useful for?	Public health research and hypothesis generation
What is the key limitation?	Ecological fallacy

EXAM TRAPS × tempting option ✓ correct answer

- × A population-level association proves individual-level causation
- ✓ This is the ecological fallacy
- × Ecological studies follow individuals over time like cohort studies
- ✓ Ecological studies compare groups; cohort studies follow individuals
- × Ecological studies are definitive for individual patient risk
- ✓ They are mainly hypothesis-generating

EVIDENCE-BASED MEDICINE · TOPIC 3 OF 4

Statistics in Medical Practice

Types of Data

Categorical Data

- Categorical data place observations into groups rather than measuring a quantity.
- Nominal data have categories with no natural order, such as blood group, sex and cause of death.
- Ordinal data have categories with a natural order, but the intervals between categories are unequal or unknown.
- Pain scores and disease severity grades are ordinal data.

EXAM TRAPS × tempting option ✓ correct answer

- × A 1–10 pain score is continuous data with equal intervals
- ✓ Pain scores are ordinal data; intervals are unequal or unknown
- × Categories written as numbers are numerical data
- ✓ Numbered categories may be nominal or ordinal (categorical)
- × Nominal categories listed in order have a true ranking
- ✓ Nominal data have no natural order, however listed

Numerical Data

- Numerical data use numbers that represent a true quantity, not merely a label or category.

- Discrete data are whole-number counts, such as the number of admissions or fractures.
- Continuous data can take any value within a range, such as blood pressure, height, weight or age.
- A rounded measurement may still be continuous if the underlying variable can be measured more precisely.
- The simplest distinction is: discrete data answer "how many?"; continuous data answer "how much?" or "how high?".

EXAM TRAPS × tempting option ✓ correct answer

- × All numbers recorded in a dataset are numerical data
- ✓ Some numbers are labels or ordered categories, not true quantities
- × Age recorded in whole years is discrete data
- ✓ It is continuous; the underlying variable can be measured more precisely
- × Number of fractures is continuous data
- ✓ It is discrete count data; fractional values (2.5 fractures) are impossible

Describing Data

Measures of Central Tendency

- The mean is the arithmetic average and is best used for normally distributed data.
- The mean is sensitive to outliers, so it may be misleading in skewed datasets.
- The median is the middle value and is robust to outliers.
- The median is preferred for skewed data.
- The mode is the most frequently occurring value.

EXAM TRAPS × tempting option ✓ correct answer

- × The mean is best for skewed data because it is the average
- ✓ The median is preferred for skewed data
- × An outlier affects the median more than the mean
- ✓ Outliers markedly change the mean; the median is robust
- × The median is the most frequently occurring value
- ✓ Median is the middle value; mode is the most frequent

Measures of Spread (Dispersion)

- Range is the difference between the maximum and minimum values, but it is sensitive to outliers.
- Interquartile range describes the middle 50% of data and is robust to outliers.
- IQR is commonly reported alongside the median, especially for skewed data.
- Standard deviation describes spread around the mean and is used for normally distributed data.
- Variance is SD squared and is less commonly reported directly.

EXAM TRAPS × tempting option ✓ correct answer

- × The range is robust to outliers
- ✓ The range is highly affected by outliers; IQR is robust
- × The median is reported with the standard deviation
- ✓ Median pairs with IQR; mean pairs with SD
- × Variance is the square root of the standard deviation
- ✓ Variance is SD squared, reported in squared units

Normal Distribution

- A normal distribution is bell-shaped and symmetrical.
- In a normal distribution, mean = median = mode.
- Around 68% of observations lie within 1 SD of the mean, 95% within 1.96 SD, and 99.7% within 3 SD.
- Normal distribution underpins many parametric statistical tests.
- In skewed distributions, the tail determines the direction of skew and the median is preferred over the mean.

EXAM TRAPS × tempting option ✓ correct answer

- × 95% of observations lie within exactly 2 SD of the mean
- ✓ The precise value is 1.96 SD
- × The mean is preferred for clearly skewed data
- ✓ The median is preferred when skew or outliers are present
- × Positive skew has its tail to the left
- ✓ Positive skew: tail to the right; negative skew: tail to the left

Hypothesis Testing and Statistical Significance

Confidence Intervals (CI)

- A confidence interval gives a range of plausible values for the true population parameter.
- A 95% confidence interval means that, if the study were repeated many times, 95% of the calculated intervals would contain the true value.
- A narrow confidence interval indicates a more precise estimate; a wide confidence interval indicates less precision.
- For differences, a 95% CI crossing 0 means the result is not statistically significant at $p < 0.05$.
- For ratios, a 95% CI crossing 1.0 means the result is not statistically significant at $p < 0.05$.
- Confidence intervals are more informative than p-values alone because they show both statistical significance and precision.

EXAM TRAPS × tempting option ✓ correct answer

- × A ratio is non-significant if its 95% CI crosses 0
- ✓ Ratios are judged against 1.0; differences against 0
- × A wide confidence interval is reassuring
- ✓ A wide interval indicates uncertainty and imprecision
- × A confidence interval only indicates statistical significance
- ✓ It also shows the precision of the estimate
- × A non-significant confidence interval proves no effect
- ✓ It may be too imprecise to exclude an effect

Null and Alternative Hypotheses

- The null hypothesis (H_0) states that there is no difference or association between groups.
- The alternative hypothesis (H_1) states that there is a difference or association.
- Statistical testing initially assumes that H_0 is true.
- The test evaluates how likely the observed results would be if H_0 were true.
- A non-significant result means failure to reject H_0 , not proof that H_0 is correct.

EXAM TRAPS × tempting option ✓ correct answer

- × A non-significant study proves the null hypothesis
- ✓ Tests either reject H_0 or fail to reject H_0
- × The alternative hypothesis implies clinical importance
- ✓ H_1 refers to a statistical difference or association, not necessarily meaningful patient benefit
- × Hypothesis testing begins by assuming the alternative hypothesis
- ✓ Testing first assumes the null hypothesis (H_0) is true

P-Value

- A p-value is the probability of obtaining results at least as extreme as those observed, assuming the null hypothesis is true.
- The conventional threshold for statistical significance is $p < 0.05$.
- $p < 0.05$ means the result is statistically significant and the null hypothesis is rejected.
- $p \geq 0.05$ means there is insufficient evidence to reject the null hypothesis.
- A p-value does not measure clinical significance, effect size, or the probability that the null hypothesis is true.

EXAM TRAPS × tempting option ✓ correct answer

- × $p < 0.05$ proves the result is true
- ✓ It supports rejecting H_0 ; it does not prove causation or truth
- × $p \geq 0.05$ proves there is no difference
- ✓ There is insufficient evidence to reject H_0
- × A statistically significant result must be clinically important
- ✓ Clinical importance depends on the size and relevance of the effect
- × The p-value is the probability that the null hypothesis is true
- ✓ It is the probability of results at least as extreme, assuming H_0 is true

Type I and Type II Errors

- A Type I error is a false positive: incorrectly rejecting a true null hypothesis.
- The probability of a Type I error is alpha, conventionally set at 0.05.
- A Type II error is a false negative: failing to reject a false null hypothesis.
- The probability of a Type II error is beta, conventionally set at 0.2.
- Power equals $1 - \text{beta}$ and represents the probability of correctly detecting a true effect.
- Power is conventionally set at 0.8, or 80%, and increases with larger sample size.

EXAM TRAPS × tempting option ✓ correct answer

- × A Type I error is a false negative
- ✓ Type I is a false positive; Type II is a false negative
- × Alpha is unrelated to the p-value threshold
- ✓ Alpha is the Type I error probability, linked to the p-value threshold, commonly 0.05
- × Failure to reject H_0 proves there is no effect
- ✓ It may be a Type II error if the study is underpowered
- × Power equals $1 - \text{alpha}$
- ✓ Power equals $1 - \text{beta}$
- × Larger sample size reduces power
- ✓ Larger studies have greater power and lower risk of Type II error

Measures of Association and Effect

Absolute and Relative Risk Reduction

- Absolute risk reduction is the difference in event rates between control and treatment groups.
- ARR is clinically meaningful because it shows the actual magnitude of benefit.
- Relative risk reduction is the proportional reduction in risk relative to the control group.
- RRR can be misleadingly large when baseline risk is low.
- NNT is calculated as $1 / \text{ARR}$ and represents the number needed to treat to prevent one additional adverse outcome.
- Lower NNT values indicate more effective treatments.
- NNH is calculated as $1 / \text{absolute risk increase}$ and describes treatment-related harm.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Relative risk reduction alone best shows clinical importance
- ✓ Absolute risk reduction shows the actual size of benefit
- × NNT for an ARR of 10% is $1/10 = 0.1$
- ✓ Convert to a proportion: $\text{NNT} = 1/0.10 = 10$
- × A high relative risk reduction always means large clinical benefit
- ✓ RRR can be misleadingly large when baseline risk is low
- × NNT describes the number treated to cause one additional harm
- ✓ That is NNH ($1/\text{absolute risk increase}$); NNT relates to prevented adverse outcomes

Correlation and Regression (Awareness Level)

Correlation	Measures the strength and direction of association between two continuous variables
Correlation coefficient (r)	Ranges from -1 to +1
r = +1	Perfect positive linear association
r = -1	Perfect negative linear association
r = 0	No linear association
Regression	Models relationships between variables to allow estimation or prediction

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A strong correlation proves causation
- ✓ Correlation does not prove causation; confounding may explain it
- × $r = -0.9$ is a weaker association than $r = +0.5$
- ✓ Sign gives direction; distance from zero gives strength
- × $r = 0$ excludes any relationship between variables
- ✓ $r = 0$ means no linear association

Diagnostic Test Statistics

Concept	Essential meaning	Exam link
Sensitivity	True positives identified among all patients with disease	High sensitivity + negative result = rules OUT
Specificity	True negatives identified among all patients without disease	High specificity + positive result = rules IN

Concept	Essential meaning	Exam link
PPV	Chance that a positive result is a true positive	Higher prevalence increases PPV
NPV	Chance that a negative result is a true negative	Lower prevalence increases NPV
LR+	Effect of a positive test on disease odds	> 10 is a large increase
LR-	Effect of a negative test on disease odds	< 0.1 is a large decrease

EXAM TRAPS × tempting option ✓ correct answer

- × Sensitivity is calculated from patients with a positive test result
- ✓ Sensitivity/specificity use true disease status; PPV/NPV use the test result as denominator
- × A highly sensitive test is best for ruling in disease
- ✓ High sensitivity + negative result rules disease out
- × A highly specific test is best for ruling out disease
- ✓ High specificity + positive result rules disease in
- × Predictive values are unaffected by disease prevalence
- ✓ PPV rises as prevalence rises; NPV rises as prevalence falls

Risk and Rates

- Absolute risk is the probability of an event occurring in a defined population over a defined period.
- Relative risk compares risk in the exposed group with risk in the unexposed group.
- Relative risk is used in cohort studies and randomised controlled trials because risk can be measured directly.
- RR = 1 means no difference; RR > 1 means increased risk; RR < 1 means reduced risk or a protective association.
- Odds ratio compares odds rather than risk and is the key measure used in case-control studies.
- OR = 1 means no association; OR > 1 means increased odds; OR < 1 means reduced odds.
- The odds ratio approximates the relative risk when the outcome is rare.

EXAM TRAPS × tempting option ✓ correct answer

- × Case-control studies report relative risk
- ✓ Case-control studies usually report odds ratios
- × An RR or OR below 1 indicates increased risk
- ✓ Values below 1 indicate reduced risk or odds (protective association)
- × Odds and risk are always identical
- ✓ They are similar only when the outcome is rare
- × An odds ratio proves causation
- ✓ It measures association; study design must still be considered

Statistical Tests

Parametric vs Non-Parametric Tests

Parametric tests	Assume a normal distribution; used for continuous normally distributed data
t-test	Compares means of two groups
ANOVA	Compares means of three or more groups
Pearson's correlation	Parametric correlation for two continuous variables
Non-parametric tests	Do not assume normality; used for skewed data, ordinal data, or small samples

Mann-Whitney U test	Non-parametric equivalent of the unpaired t-test (Wilcoxon signed-rank for paired data)
Kruskal-Wallis test	Non-parametric equivalent of ANOVA
Spearman's correlation	Non-parametric equivalent of Pearson's correlation
Chi-squared test	Used for categorical data; compares observed with expected frequencies

EXAM TRAPS × tempting option ✓ correct answer

- × A t-test is appropriate for ordinal data such as pain scores
- ✓ Ordinal data usually need a non-parametric test
- × Chi-squared test is used for continuous measurements
- ✓ Chi-squared is for categorical counts or frequencies
- × A t-test compares means across three or more groups
- ✓ ANOVA compares means of three or more groups; t-test compares two

EVIDENCE-BASED MEDICINE · TOPIC 4 OF 4

Critical Appraisal

Principles of Critical Appraisal

Appraisal of Study Validity

- Validity appraisal asks whether the study methods are good enough for the results to be trusted.
- The study design must match the clinical question being asked.
- A representative sample and accurate outcome measurement reduce bias.
- Confounding must be identified and controlled, especially in observational studies.
- Follow-up must be both complete and long enough for the outcome to occur.
- Adequate power is essential for interpreting negative findings confidently.

EXAM TRAPS × tempting option ✓ correct answer

- × A statistically significant result is trustworthy despite major design flaws
- ✓ Validity depends on sound design and measurement, not significance alone
- × A cross-sectional association proves causation
- ✓ It cannot establish temporal sequence
- × Loss to follow-up is a minor issue in appraisal
- ✓ It may introduce attrition bias; follow-up must be complete and long enough
- × A negative small underpowered study proves no effect
- ✓ Adequate power is needed to interpret negative findings confidently
- × Confounding can be ignored when groups differ at baseline in observational studies
- ✓ Confounding must be identified and controlled, especially in observational studies

Purpose of Critical Appraisal

Validity	Can the study result be trusted?
Results	What is the finding and how large is the effect?
Relevance	Can the result reasonably be applied to my patient?
Internal validity	Truth of the result within the study.

External validity	Applicability of the result beyond the study.
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EXAM TRAPS × tempting option ✓ correct answer

- × An internally valid study must apply to every patient and setting
- ✓ Validity ≠ relevance; an internally valid study may still not be applicable to a particular patient or setting
- × A statistically significant p-value means the result is clinically useful
- ✓ Clinical usefulness depends on effect size and applicability, not just the p-value
- × Appraisal starts by interpreting results, then checks validity
- ✓ Sequence: validity first, then interpret results, then consider applicability

The Three Core Questions of Critical Appraisal

Is the study valid?	Assess the methods. Look for threats to internal validity such as bias, confounding, poor measurement, and inadequate follow-up.
What are the results?	Interpret the statistics. Focus on effect size, precision, confidence intervals, and clinical as well as statistical significance.
Will the results help my patients?	Assess applicability. Decide whether the study population, setting, intervention, outcomes, benefits, and harms fit the clinical decision.

EXAM TRAPS × tempting option ✓ correct answer

- × A statistically significant result means the study is valid
- ✓ Significance says nothing about validity; validity is judged from the methods (bias, confounding, measurement, follow-up)
- × A methodologically sound study is applicable to any patient group
- ✓ Internal validity ≠ external validity; a sound study may not apply to a particular patient group
- × A large relative risk reduction alone shows the treatment is worthwhile
- ✓ Also consider absolute benefit, confidence intervals and clinical relevance

Bias

Definition of Bias

Definition	Systematic error in design, conduct, analysis, or interpretation of a study.
Effect	Distorts the true association between exposure and outcome.
Main appraisal issue	Threatens validity: the result may not be true.
Important distinction	Bias is systematic distortion; random error is chance variation.

EXAM TRAPS × tempting option ✓ correct answer

- × Bias means any error, including random imprecision
- ✓ Bias is systematic distortion; random imprecision is chance variation (random error)
- × A large sample size removes bias
- ✓ Large samples reduce random error only; they may just narrow the confidence interval around a biased estimate
- × A significant p-value confirms the result is true
- ✓ First ask whether systematic error (bias) could have distorted the result; significance does not exclude bias

Publication Bias

Definition	Positive or significant studies are more likely to be published than negative or null studies.
Main effect	The evidence base becomes skewed towards positive findings.
Where tested	Most commonly considered when appraising systematic reviews and meta-analyses.
Detection	A funnel plot is used; asymmetry suggests possible publication bias.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × A meta-analysis is automatically reliable
- ✓ A meta-analysis can be distorted by publication bias if positive studies are over-represented
- × Publication bias is a form of selection bias in participant recruitment
- ✓ Publication bias concerns which studies become visible in the literature; selection bias concerns how participants enter a study
- × An asymmetrical funnel plot proves publication bias
- ✓ Funnel plot asymmetry only suggests possible publication bias and should prompt caution

Types of Bias

When identifying bias in an MCQ, ask where the problem entered the study. If the issue is recruitment, representativeness, volunteers, or dropouts, think selection bias. If the issue is memory, self-report, observer judgement, or behaviour changing because participants are being watched, think information bias. If the issue is a third factor linked to both the exposure and the outcome, think confounding.

⚠ EXAM TRAPS × tempting option ✓ correct answer

- × Inaccurate recall of exposure is a form of selection bias
- ✓ That is information bias (data accuracy); selection bias concerns which participants are selected or retained
- × Any third variable associated with the outcome is a confounder
- ✓ A true confounder must be associated with both the exposure and the outcome
- × Recall bias is the key bias in prospective cohort studies
- ✓ Recall bias is classic in case-control studies, which look backwards at past exposure via memory or reporting
- × A significant p-value rules out bias
- ✓ Significance does not correct flawed selection, poor measurement or uncontrolled confounding
- × Blinding is the main method to reduce confounding in RCTs
- ✓ Randomisation mainly reduces confounding; blinding mainly reduces observer bias

Validity and Generalisability

External Validity (Generalisability and Applicability)

Definition	Degree to which study results can be applied to patients outside the study population.
Alternative terms	Generalisability and applicability.
Patient similarity	Are the study patients sufficiently similar to my patient?
Setting and feasibility	Could the intervention be delivered in a real-world ED setting?
Outcomes	Were clinically important outcomes reported?
Overall judgement	Do benefits justify harms and costs for this patient?

EXAM TRAPS × tempting option ✓ correct answer

- × External validity means the study is free from bias
- ✓ External validity is applicability; freedom from bias is internal validity
- × A high-quality trial applies to every patient
- ✓ A valid study may have excluded the type of patient in the question stem
- × An intervention effective in a specialist research setting will work in any ED
- ✓ Feasibility is part of external validity; it may not be realistic in a busy ED
- × A statistically significant outcome is necessarily clinically important
- ✓ Check whether reported outcomes are clinically important, not only statistically significant

Internal Validity

Definition	Accuracy of the study result in reflecting the true exposure-outcome relationship in the study population.
Main focus	Whether the result is true for the participants studied.
Main threats	Bias and confounding.
Appraisal implication	Poor internal validity means the result may be misleading, regardless of statistical significance.
Do not confuse with	External validity, which asks whether the result applies beyond the study population.

EXAM TRAPS × tempting option ✓ correct answer

- × Internal validity means generalisability
- ✓ Internal validity: is the result true in the study population; generalisability (external validity): does it apply elsewhere
- × A low p-value proves the study is valid
- ✓ Statistical significance does not remove bias or confounding, the main threats to internal validity
- × A large study is automatically internally valid
- ✓ Large studies can still be systematically wrong if design or conduct is flawed

Appraising Different Study Types

Appraising a Diagnostic Study

Gold standard	Was the test compared with the best available method of confirming disease status?
Independent comparison	Did the result of one test avoid influencing interpretation of the other?
Blinding	Were assessors unaware of the other test result when judging each result?
Patient spectrum	Were patients representative of those in whom the test would be used clinically?
Sensitivity and specificity	Were both false negative and false positive performance described?
PPV and NPV	Were predictive values reported, recognising their dependence on prevalence?
Likelihood ratios	Were LR+ and LR- reported to show changes in disease probability?
Reliability	Can the test results be reproduced in repeated use or by different observers?

EXAM TRAPS × tempting option ✓ correct answer

- ✗ High sensitivity alone makes a test clinically useful
- ✓ Specificity and false positives must also be checked
- ✗ PPV and NPV are fixed properties of a test
- ✓ PPV and NPV change with disease prevalence
- ✗ Accuracy in obvious cases versus healthy controls applies to real diagnostic uncertainty
- ✓ Patient spectrum must be representative of those in whom the test is used clinically
- ✗ Blinding is unimportant when comparing an index test with the gold standard
- ✓ The index test should be interpreted blind to the gold-standard result
- ✗ An accurate test is automatically reliable
- ✓ Accuracy ≠ reliability; a useful test must be both accurate and reproducible

Appraising a Systematic Review or Meta-Analysis

- A systematic review is not automatically valid simply because it sits high in the evidence hierarchy.
- The search strategy should be comprehensive enough to find all relevant studies, not just convenient or positive studies.
- Inclusion and exclusion criteria should be clear, predefined, and applied consistently.
- The quality of the included studies must be assessed; poor-quality primary studies weaken the review.
- Heterogeneity must be assessed before accepting a pooled result from a meta-analysis.
- Forest plots and funnel plots are central to appraising meta-analyses: forest plots show pooled effect and precision; funnel plots help assess publication bias.

EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ A meta-analysis is always reliable because it combines several studies
- ✓ It may still mislead if included evidence is poor-quality or heterogeneous
- ✗ The pooled diamond alone is sufficient to interpret a forest plot
- ✓ Also assess heterogeneity and the confidence intervals of individual studies
- ✗ The line of no effect is 0 for odds and risk ratios
- ✓ Line of no effect is 1.0 for ratios and 0 for differences
- ✗ Funnel plot asymmetry is absolute proof of publication bias
- ✓ Asymmetry suggests possible publication bias and should prompt caution

Appraising a Therapeutic Study (RCT)

Randomisation	Were patients randomly allocated to intervention and control groups?
Allocation concealment	Could the next treatment assignment be predicted or influenced before enrolment?
Blinding	Were patients, clinicians, and outcome assessors blinded where possible?
Follow-up	Were all patients accounted for, and were losses balanced between groups?
Intention-to-treat	Were patients analysed in their originally assigned groups?
Baseline characteristics	Were groups similar for important prognostic factors at the start?
Effect measures	Were results expressed as ARR, RRR, and NNT?

EXAM TRAPS ✗ tempting option ✓ correct answer

- ✗ Allocation concealment and blinding are the same thing
- ✓ Concealment protects enrolment before allocation; blinding protects care and outcome assessment after allocation
- ✗ Randomisation always guarantees identical groups

- ✓ Baseline characteristics must still be checked for important prognostic factors
- ✗ Per-protocol analysis is equivalent to intention-to-treat analysis
- ✓ Per-protocol can exaggerate treatment benefit; intention-to-treat analyses patients in originally assigned groups
- ✗ A large RRR shows a large clinical benefit
- ✓ Consider ARR and NNT; a large RRR may represent small absolute benefit
- ✗ Loss to follow-up does not matter in a well-randomised RCT
- ✓ Missing outcome data can undermine an otherwise well-designed RCT; losses should be balanced and accounted for

WHERE TO GO FROM HERE

Turn high-yield into marks

Knowing a fact and picking it out from several plausible options against the clock are different skills. The second only comes from practice questions. MrcemUltra is built for exactly that.

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