



RCEM

Basic Sciences Curriculum

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1. Summary of the anatomy curricular content

The aim of this document is to enable trainees to focus their learning on those aspects of basic anatomy which will be of most clinical relevance in professional practice. This relevance has been established in a national research project involving over eighty senior emergency medicine clinicians. You can be confident that, if you have revised and understood the key anatomy outlined in the above document, you will be able to correctly answer the anatomy questions within MCEM. Moreover you will be extremely well-equipped to safely and speedily interpret many common clinical presentations.

Although this document is primarily a reference tool for the MCEM diploma, remember that learning must be life-long. You are strongly advised to revisit the contents of this document periodically as you develop within the specialty: it constitutes a benchmark of knowledge of anatomy for your future continuing professional development.

Introduction

This document contains the draft core content for the MCEM Examination in relation to anatomy. Eventually, questions will be set based upon the listed topics which follow. Where appropriate, comments are included to guide you in relation to the depth of knowledge required.

Whilst learning the core content, remember that the importance of anatomy rests upon its implications for safe clinical practice. The functional effects of damage to a given structure are only predictable if you know the location and action of that structure. This is the important principle.

The content of the document has been derived through systematic analysis of expert group opinion. This methodology represents one of the best established ways of determining relevant knowledge.

Format

The document is arranged logically based upon anatomical regions. There is naturally some overlap between regions and this means that some structures may be mentioned more than once. This does not reflect a particular importance of that structure.

Learning the content

This document tells you what you need to know but does not tell you how to learn it. Individual learning styles vary from rote-remembering of lists to patient-based learning. What matters is that you find a learning style which suits your abilities and aptitude. If you are finding this difficult, seek advice from your educational supervisor.

Review and corrections

This curriculum is subject to periodic review to ensure that it meets its educational objectives. If you have any comments to make in relation to the accuracy or terminology of its content then please contact us at the College and we will be happy to hear from you.

Section 1: Upper limb

PECTORAL REGION	
Muscles	Surface markings, actions and nerve supply of: <ul style="list-style-type: none">• Pectoralis major• Pectoralis minor• Trapezius• Latissimus dorsi• Serratus anterior
Joints	<ul style="list-style-type: none">• Sternoclavicular• acromioclavicular joints <p>An appreciation of their role in producing pectoral movement and the fact that their stability rests upon ligaments. The role of the ACJ in force transmission following a fall.</p>
AXILLA	
Muscles (see also below)	Surface markings, actions and nerve supply of: <ul style="list-style-type: none">• Subscapularis• Teres major
Contents	<p>Appreciation that the axilla transmits the neurovascular bundle from the neck to the upper limb</p> <p>Axillary artery as a source of the blood supply to the circumflex humeral arteries. Detailed knowledge of the branches of the axillary artery NOT required</p>
Brachial plexus	<p>Knowledge of its root derivation (C5-T1)</p> <p>Broad appreciation of the root / trunk / division / cord structure</p> <p>Detailed knowledge of which nerves derive through which cord NOT required</p> <p>Appreciation of the potential for plexus damage based upon its position in the axilla</p>

BREAST	
<p>Lymph drainage pattern to nodes based upon quadrants of the breast: its significance for patients presenting with breast lumps and/or lymphadenopathy</p> <p>Appreciation of the landmarks for chest drain insertion</p>	
SHOULDER	
Muscles and movements	<p>Actions and innervation of:</p> <ul style="list-style-type: none"> • Supraspinatus • Infraspinatus • Teres minor • Deltoid <p>Knowledge of origins and insertions NOT required</p> <p>Knowledge of the muscles which exert group effects (eg abduction) at the shoulder joint and the means of clinical testing: an ability to describe shoulder movements according to muscle actions and an appreciation of the role of humeral & scapular rotation</p>
Shoulder joint	<p>Joint type</p> <p>Stability factors of the joint – names of the ligaments which provide support (eg coracoacromial) and their positions in relation to the joint</p> <p>The components of the coraco-acromial arch</p> <p>The muscles and tendons which provide stability (eg rotator cuff)</p>
THE ANTERIOR ARM	
<p>Note: the arm is divided anatomically to facilitate learning. Question stems may involve knowledge from several of these subsections</p>	
Muscles and movements	<p>Actions & innervation of:</p> <ul style="list-style-type: none"> • Coracobrachialis • Biceps • Brachialis <p>Knowledge of origins & insertions is NOT required but an appreciation of the surface topography is required, for example in relation to the palpation of brachial pulsation in relation to biceps at the elbow</p>

Brachial artery	<p>Appreciation of it being a continuation of the axillary artery</p> <p>Its anatomical landmarks for palpation</p> <p>Its main branches:</p> <ul style="list-style-type: none"> • Profunda brachii • Muscular • Nutrient • Ulnar collateral • Terminal (radial & ulnar) <p>Appreciation that venae comitantes accompany the brachial artery</p>
Median nerve	<p>Formation from medial and lateral plexus roots</p> <p>Surface marking</p> <p>Musculocutaneous nerve</p> <p>Territory of supply in anterior arm. Appreciation that it is the nerve of the flexor component of the arm</p>
Ulnar nerve	Surface marking
Other nerves of the compartment	<p>Knowledge of the territories of:</p> <ul style="list-style-type: none"> • Medial cutaneous nerve of arm and forearm • Intercostobrachial nerve
Lymph nodes	Positions of the infraclavicular and supratrochlear node groups and the regions they drain
THE POSTERIOR ARM	
Muscles and movements	Actions & innervation of triceps
Radial nerve	<p>Its position relative to the humerus and the clinical implications of this</p> <p>Surface marking</p> <p>Its role in supply to triceps</p>

Elbow joint	<p>Joint type</p> <p>Bony articulations of the joint</p> <p>Ligaments of the elbow (collaterals and annular): their structure as bands of ligament (collaterla) and the role of the annular ligament in radial rotation</p> <p>Knowledge of the muscles which exert movement about the elbow. The range of movement of the joint in health and the risk of ulnar nerve palsy from pathological increase of the carrying angle</p>
THE ANTERIOR FOREARM	
Muscles	<p>Appreciation of a common origin from the medial humeral epicondyle</p> <p>Actions & innervation of:</p> <ul style="list-style-type: none"> • Pronator teres • Flexor carpi radialis • Flexor digitorum superficialis • Palmaris longus • Flexor carpi ulnaris • Flexor digitorum profundus • Flexor pollicis longus • Pronator quadratus <p>Detail in relation to attachments and relations is NOT required but the surface topography in relation to injuries at any given point should be appreciated in order to predict possible muscular damage and functional disability</p>
Vessels of the compartment: arteries	<p>Appreciation of the division of the brachial artery halfway through this region</p> <ul style="list-style-type: none"> • Radial artery: surface marking • Ulnar artery: surface marking and as source of common interosseous artery • Wrist anastomosis • Derivation and location of the anterior and posterior carpal arches and their territory of supply

Vessels of the compartment: veins	Appreciation of the fact that venae comitantes accompany the main arteries The cephalic, basilic and median forearm veins as the main superficial veins and broad knowledge of their location
Nerves of the flexor compartment	Lateral and medial cutaneous nerves of forearm: supply territories Median nerve: Branches given off in this compartment and structures supplied. Its surface marking and the clinical implications of its division Ulnar nerve: Structures supplied in this compartment. Surface marking
Radioulnar joints	Appreciation that the proximal (see Elbow above) and distal radioulnar joints allow rotational movement of these two bones Movement: muscles exerting and allowing flexion, extension and rotation (see also individual muscle names)
POSTERIOR COMPARTMENT OF THE FOREARM	
Muscles and movements	Actions & innervations of: <ul style="list-style-type: none"> • Brachioradialis • Extensor carpi radialis longus • Extensor carpi radialis brevis • Extensor digitorum • Extensor carpi ulnaris • Supinator • Abductor pollicis longus • Extensors pollicis longus & brevis • Extensor indicis <p>Note – although detailed knowledge of attachments and relations is not required, particular focus should be given to the clinical effects of injury or division of any of these muscles or their tendons</p>
Anatomical snuffbox	Its position and anatomical boundaries Its clinical significance Bones palpable within it
Extensor retinaculum	Its position and attachments to bone The relations of the long extensors as they pass beneath it

WRIST AND HAND

Note: The anatomy of this region represents key knowledge for Emergency Medicine. Although questions will focus on functional effects of injury, only by a thorough grasp of the arrangement of the structures listed can competence be gained. You are strongly advised to equip yourself with as detailed knowledge of the hand as possible.

Movements of the wrist joint	<p>Muscles which exert flexion / extension / adduction / abduction</p> <p>Palmar aponeurosis</p> <p>Its structure (slips) and function (mechanical)</p>
Flexor retinaculum	<p>Its attachments</p> <p>Appreciation that the thenar and hypothenar muscles arise from it</p> <p>Structures which pass above and below the retinaculum</p>
Carpal tunnel	<p>Its constituents: the separated tendons of the superficial flexors and the different arrangement of the deep tendon. Position of the median nerve in the tunnel</p>
Thenar eminence	<p>Actions & innervation of:</p> <ul style="list-style-type: none"> • Abductor pollicis brevis • Flexor pollicis brevis • Opponens pollicis
Hypothenar eminence	<p>Actions & innervation of:</p> <ul style="list-style-type: none"> • Abductor digiti minimi • Flexor digiti minimi • Opponens digiti minimi
Palmar arches	<p>Appreciation that there are two arches in the palm</p> <p>Their constituents and the territories supplied</p> <p>The clinical implications of injury to the arches</p>
Digital nerves	<p>Ulnar & median nerves: territories supplied and the particular importance of the recurrent branch of the median nerve</p> <p>Surface anatomy of the digital nerves as they enter and supply each digit in relation to injury and anaesthetic field blockade</p>

Lumbricals and interossei	<p>Lumbricals: derivation from profundus tendons</p> <p>Anatomical attachments</p> <p>Nerve supply and actions</p> <p>Interossei: derivations and grouping into palmar and dorsal groups</p> <p>The actions of each group</p> <p>Nerve supply</p>
The flexor sheaths	Appreciation of the disposition of the tendons within flexor sheaths in terms of infection in the thenar or midpalmar spaces and the risks to the lumbrical canals
THE DIGITAL ATTACHMENTS OF THE LONG TENDONS	
<p>This section warrants a separate heading. A detailed knowledge is expected of the anatomy of the attachments of both the flexor and extensor tendons, particularly to allow understanding of the clinical effects of division or injury at any given level of the finger.</p>	
OTHER ASPECTS OF UPPER LIMB ANATOMY	
Innervation	<p>The dermatomal (segmental) supply of the limb (based upon standard dermatomal maps)</p> <p>Muscular innervation: knowledge of the nerves implicated in all major upper limb movements (e.g. elbow flexion, adduction of the wrist)</p> <p>Injuries to nerves: knowledge of the likely clinical effects resulting from:</p> <ul style="list-style-type: none"> • Traction injury to the brachial plexus (Erb palsy) • All-root damage to the brachial plexus • Axillary nerve damage (and common precipitants of it) • Radial nerve • Ulnar nerve • Median nerve
UPPER LIMB BONY ANATOMY AND RADIOLOGY	
<p>Knowledge of osteology need extend only to an appreciation of the key attachment points for soft tissues specifically mentioned above.</p> <p>Topographical anatomy of individual bones is NOT required</p>	

Radiological anatomy is not explicitly assessed by MCQ but the other components of the examination will test knowledge of the key and common radiological landmarks in relation to clinical injury. These do not fall within the scope of this document.

Section 2: Lower limb

General introduction

Required anatomy knowledge for lower limb follows the same principles as upper limb: emphasis is placed on those key structures which are of high clinical importance by virtue of their location, relations or actions. In learning the required content, approach the material from the viewpoint of shopfloor clinical practice. The MCEM exam will assess your grasp of the lower limb anatomy detailed below. You can assume that, where a given structure is not specifically listed, then details of it will not be required.

The limb is divided to facilitate learning but questions may contain material from several regions in one stem.

ANTERIOR THIGH	
Superficial innervation	Dermatomal pattern of innervation The names of the specific nerves (eg genitofemoral) are not required
Superficial arteries	Appreciation that cutaneous arteries arise from the femoral artery The names of the specific arteries (e.g. superficial epigastric) are not required
Superficial veins	Great saphenous vein: <ul style="list-style-type: none"> • Surface marking throughout the compartment • The common pattern of its tributaries
Lymph nodes / vessels	Location and drainage territories of the superficial and deep inguinal nodes
Muscles and movements	Actions and innervation of: <ul style="list-style-type: none"> • Sartorius • Iliacus • Psoas major • Pectineus • The group actions of these muscles as hip flexors and medial femoral rotators

	<p>Actions and innervation of:</p> <ul style="list-style-type: none"> • Quadriceps femoris • Rectus femoris • Vasti lateralis, intermedius and medialis <p>The group actions of these muscles as knee extensors Attachments not required</p>
Femoral sheath	<p>Appreciation of its origin as a prolongation of extraperitoneal fascia</p> <p>Surface marking</p>
The femoral canal and femoral ring.	
Femoral artery	<p>Surface marking at point of entry into thigh</p> <p>Details of its named branches (eg lateral circumflex femoral) not required</p>
Femoral vein	<p>Surface marking and clinical significance (line insertion)</p>
Femoral nerve	<p>Derivation (L2,3,4)</p> <p>Surface marking at point of entry into thigh</p> <p>Superficial and deep branches as the source of cutaneous and muscular supply</p> <p>As the source of the saphenous nerve</p>
Patellar region	
<p>Patellar ligament and the patellar bone as a sesamoid bone</p> <p>The bony, ligamentous and muscular factors preventing lateral patellar draw</p>	
MEDIAL THIGH	
Muscles and movements	<p>Adductors longus, brevis & magnus as the prime adductors of the hip. Their role in medial femoral rotation and the clinical test of their integrity</p> <p>Nerve supply of the adductors. Attachments not required</p> <p>Obturator externus:</p> <ul style="list-style-type: none"> • Actions and innervation (attachments not required)
Arteries and nerves	<p>Profunda femoris artery as the key artery of the region supported by obturator artery</p> <p>Obturator nerve: Territory of supply</p>

HIP JOINT & GLUTEAL REGION	
Cutaneous innervation	Appreciation of supply via posterior and anterior rami of lumbosacral nerves: the dermatomal pattern
Muscles and movements	<p>Actions and innervation of:</p> <ul style="list-style-type: none"> • Gluteus maximus • Gluteus medius • Gluteus minimus • Piriformis <p>Appreciation of piriformis, obturator internus and quadratus femoris as synergistic femoral lateral rotators and hip stabilisers: attachments not required</p>
Sciatic nerve	<p>This nerve is highlighted as a key structure. You should know its derivation and surface marking at both the point of entry into the buttock and at the top of the thigh</p> <p>Clinical relevance for i.m. injections</p> <p>Correct identification of the upper outer quadrant based upon regional landmarks</p>
Hip joint	<p>Bony components of the acetabulum.</p> <p>Ligaments of the joint as providers of stability:</p> <ul style="list-style-type: none"> • Transverse ligament • Ligamentum teres • Iliofemoral ligament • Pubofemoral ligament • Ischiofemoral ligament <p>Blood supply of the capsule and synovium</p> <p>Nerve supply of the hip joint</p>
Movements	<p>The prime movers in relation to:</p> <ul style="list-style-type: none"> • Flexion • Extension • Adduction • Abduction • Thigh rotation

POSTERIOR THIGH COMPARTMENT	
Muscles and movements	<p>Hamstrings:</p> <ul style="list-style-type: none"> • Names • Actions • Innervation • Clinical test of integrity
Sciatic nerve	Surface marking in this region and territory supplied
POPLITEAL FOSSA AND KNEE	
<p>The knee joint is complex and clinically highly relevant for Emergency Medicine. Your knowledge of the arrangement of the structures of the knee will facilitate a clearer understanding of the clinical symptoms and signs generated by anatomical injury.</p> <p>Although detailed knowledge of the contents of the popliteal fossa is not required, pay attention to the highlighted material below which is of particular relevance and which may be assessed in MCEM.</p>	
Boundaries and composition of the popliteal fossa	<p>Structures comprising the boundaries of the fossa</p> <p>Arrangement of major neurovascular structures across the fossa – tibial nerve, popliteal artery, popliteal vein, common peroneal nerve</p> <p>Position and technique for palpation of popliteal pulse</p>
Muscles and movements	<p>Popliteus:</p> <ul style="list-style-type: none"> • Innervation • Actions (on the femur / tibia and its role in lateral meniscus movement)
Knee joint	<p>Bony anatomy: Appreciation of the way in which the condyles are anatomically adapted for the 'screw-home' movement (see below)</p> <p>Capsule: Detail not required, but appreciation of its openings for popliteus & suprapatellar bursa</p> <p>Ligaments: Tibial & fibular collaterals, Oblique popliteal</p> <p>Cruciates Menisci</p> <p>Although a detailed knowledge of the attachments and relations of these ligaments is not required, you should be aware of the principal actions and roles of each</p> <p>Bursae: Names and communications</p>

Movements of the knee Muscles effecting movement	'Screw-home' mechanism and 'locking' Role of menisci
Stability of the knee	Role of tibial spines, cruciates, muscles
ANTERIOR LEG	
Muscles	<p>Actions and innervation of:</p> <ul style="list-style-type: none"> • Tibialis anterior • Extensor hallucis longus • Extensor digitorum longus • Peroneus tertius • Sartorius • Gracilis • Semitendinosus (see other regions) <p>Appreciation of the attachment of the patellar ligament and the disposition of the patellar bursae</p>
DORSUM OF THE FOOT	
Innervation	Cutaneous nerves supplying the dorsum (dermatomes and names)
Vessels	<p>Dorsalis pedis artery:</p> <ul style="list-style-type: none"> • As a continuation of the anterior tibial artery • Its surface marking • Knowledge of its branches not required
LATERAL LEG	
Muscles	<p>Actions & innervation of: Peroneus longus & brevis</p> <p>Appreciation of their arrangement around the lateral malleolus</p> <p>Appreciation of the insertions of the peronei and the clinical correlation to inversion injuries at the ankle</p>

POSTERIOR LEG (CALF)

Knowledge of calf anatomy assists in understanding the basis of deep vein thrombosis and compartment syndrome

Appreciation that the calf muscles fall into two groups

An understanding of the arrangement of the muscles and vessels of the calf in cross-section: the association of deep veins around soleus and the potential for DVT

Muscles and movements	<p>Actions and innervation of:</p> <ul style="list-style-type: none"> • Gastrocnemius • Soleus • Flexor digitorum longus • Flexor hallucis longus • Tibialis posterior
Vessels	<p>Posterior tibial artery:</p> <ul style="list-style-type: none"> • As derived from the popliteal artery • Surface marking at the medial malleolus • Named branches NOT required
Nerves	<p>Tibial nerve:</p> <ul style="list-style-type: none"> • As the nerve of the flexor compartment • Surface marking

SOLE OF THE FOOT

Appreciation that the sole is layered and that plantar arteries and nerves lie between the first and second layers. This has implications for the structures likely to be compromised when the sole is injured.

The four layers	<p>Detailed knowledge of the muscles which lie within a given layer is not required but it is expected that candidates will know that the long flexor tendons lie within the second layer and that the tendons of tibialis posterior and peroneus longus are part of the fourth.</p> <p>Appreciation that the neurovascular plane lies between the first and second layers</p>
Individual muscles	<p>Actions & innervation of:</p> <ul style="list-style-type: none"> • Peroneus longus • Tibialis posterior <p>Knowledge of the sites of insertions of these to the</p>

	bones of the feet
ANKLE AND FOOT JOINTS ; JOINT DYNAMICS	
Ankle joint	<p>The weightbearing surfaces (talus & tibia)</p> <p>The stabilising surfaces (malleoli)</p> <p>Stabilising ligaments:</p> <ul style="list-style-type: none"> • Deltoid • “Lateral” <p>Knowledge of the attachments and function of these ligaments is expected</p>
Ankle movements	<p>The role of the talus and the implications of its shape for joint stability in dorsiflexion and plantarflexion</p> <p>The axis of rotation of the ankle</p>
Tarsal joints	<p>Names of the tarsal bones and their relations to each other</p> <p>Appreciation of the role of interosseous plantar ligaments: names not required.</p> <p>Spring ligament:</p> <ul style="list-style-type: none"> • position • function
Foot movements	<p>Candidates should possess sufficient anatomical knowledge to appreciate that inversion & eversion involve the midtarsal and subtalar joints and should know what bones make up these joints</p> <p>Muscles exerting inversion & eversion</p> <p>Supporting mechanisms of the foot</p> <p>Knowledge of which parts of the foot rest on the floor when standing normally</p> <p>Constituent bones of the medial & lateral arches</p> <p>Appreciation of the prime muscular and tendinous factors in maintaining the medial arch and the fact that ligaments alone cannot maintain the medial arch if muscles are damaged</p> <p>The soft tissue factors contributing to lateral longitudinal arch stability</p>

LOWER LIMB INNERVATION	
Candidates should possess sufficient anatomical knowledge to be able to predict the clinical effects of damage to:	<ul style="list-style-type: none"> • Femoral nerve • Lateral cutaneous femoral nerve • Obturator nerve • Sciatic nerve • Common peroneal nerve
LOWER LIMB OSTEOLOGY	
<p>The normal x-ray appearances of the bones of the lower limb and foot should be known together with the names of all bones</p> <p>Common variants of normal will not be required in detail</p> <p>You should be aware of the typical radiological appearances of fractures of the femur, tibia, fibula, malleoli and foot</p>	

Section 3: Thorax

Introduction

The level of knowledge required is stated below. Throughout, items with particular clinical significance are highlighted. Where structures are mentioned, the detail required is clarified.

THORACIC WALL

Thoracic body wall:

- The dermatomal innervation map of the thoracic body wall
- Appreciation of the structure of the body wall: ribs and their articulations; the particular articulations of the first rib (with T1 not C7)
- Arrangement of muscles of the thoracic wall into three layers: details of the constituent muscles of the outer layer not required except for knowledge of the external intercostals as part of this layer
- Intermediate muscle layer: internal intercostals
- Innermost layer: innermost intercostals & transversus as main components

Thoracic movements:

- The main muscular actions effecting a cycle of respiration
- The 'pump handle' and 'bucket handle' actions of upper/lower ribs and the anatomical rationale for these actions
- Movements of the abdominal wall in normal and abnormal respiration
- Appreciation of the central control of respiration

Intercostal structures:

- The cross-sectional anatomy of an intercostal space. Implications for pleural aspiration and chest tube insertion
- Detailed knowledge of the derivation, course and territories of the intercostal nerves, arteries and veins is not required

DIAPHRAGM

- Appreciation of its essential respiratory role
- The surface markings of the diaphragm

Openings and landmarks:

- The three main openings (aortic, oesophageal, vena caval) and their vertebral levels

Innervation:

- Innervation from the phrenic nerve; the ramifications of the nerve on the muscle

Actions:

- Appreciation of the ways in which the diaphragmatic movements contribute to inspiration and straining

Herniations:

- Congenital and acquired: outline details only

SURGICAL APPROACH TO THE THORAX

- Knowledge of the key structures implicated in anterolateral or posterolateral thoracotomy or median sternotomy
- Candidates will be expected to know the anatomical disposition of structures routinely divided during thoracotomy and the nearby structures which are also at risk

THORACIC INLET

- The key aspect of knowledge here is an appreciation of the arrangement of structures at the inlet to allow understanding of the consequences of trauma or disease within this important region

Anatomy of the inlet:

- Relations of the key structures to each other at the thoracic inlet: oesophagus, trachea, subclavian arteries, aortic arch, subclavian veins, brachiocephalic trunk
- A detailed knowledge of the anatomical course of the individual major structures is not required. The branches of the aortic arch should be appreciated but their anatomical course is not required. Likewise, apart from appreciation of the relations at the inlet, knowledge of the formation of the brachiocephalic veins and superior vena cava is not required

TRACHEA

Appreciation of its primary functions and the adaptations it possesses for these functions:

- Elastic walls
- Hyaline cartilage
- Mucous membrane

The anatomical landmarks defining its upper and lower extremities.

- Appreciation of those structures which lie in close proximity to the trachea in the thorax (oesophagus, veins, arteries, lung) in relation to potential for injury or involvement in local disease processes. Detailed knowledge of the anatomical relations not required
- See also head and neck section

THYMUS

- Anatomical location and implications for injury or local pathology
- Natural history of regression after puberty

HEART AND PERICARDIUM

General notes:

Knowledge of cardiac anatomy and the structures surrounding the heart is vital for competent assessment of normal and abnormal function: auscultation and potentially life-saving interventions such as pericardiocentesis are both equally reliant on this knowledge

Throughout this section, remember that knowledge of the following is not required:

- Development of the sinuses of the serous pericardium
- The anatomy of the individual cardiac chambers
- The structure of the heart valves
- The anatomy of the conducting system other than as specifically detailed below
- The anatomy of the coronary arteries
- Development of the heart

Focus your learning on those aspects of cardiac and pericardiac anatomy with relevance to clinical assessment, injury and disease

Pericardium:

- The fibrous and serous layers and their roles
- Nerve supply of the fibrous pericardium and its role in the pain of pericarditis vs ACS

Heart:

- Appreciation of the cardiac structures making up the borders and surfaces of the normally-orientated heart (eg right border = right atrium)
- Surface markings of the heart
- Surface markings of the heart valves and also the auscultation positions for each valve

Great vessels:

- Origins and relations of the ascending aorta and pulmonary trunk to each other as they emerge from their orifices

Conducting system:

- Overview of the nature of the pathway; anatomical location of the SA and AV nodes and the nature of impulse transmission via left and right bundles

Cardiac blood supply:

- Origin of the coronary arteries from the aortic root
- The two named principal branches of each coronary artery and the territory they supply; appreciation of the 'standard' description of the territories supplied by each coronary artery and the specific supply of the nodes
- Anatomy of the cardiac veins is not required

Procedural anatomy:

- Candidates will be expected to know the procedural steps for pericardial aspiration and be able to relate this to relevant anatomical landmarks

OESOPHAGUS

- Anatomical extent (C6-T10)
- Position of the oesophagus in relation to the vertebral bodies, left bronchus, thoracic aorta and pericardium en route to the diaphragm and the surface marking of the point where it pierces the diaphragm
- The points of constriction
- Oesophageal nerve supply in relation to referred pain

PLEURA AND LUNGS

General note

As with cardiac anatomy, knowledge here is focussed upon clinical relevance. Items which are NOT required knowledge are:

- Anatomical arrangement of the components of the lung roots
- Divisions / segments of the bronchi or their blood supply / lymph drainage
- Developmental anatomy

Pleura:

- Parietal & visceral pleura: functions. Nerve supply
- Surface markings and implications for aspiration & drainage

Lungs:

- Appreciation of the numbers of lobes in each lung; the overall structural arrangement of bronchi, pulmonary arteries and veins and the principles of subdivision within the lung substance
- The lung roots as key structures connecting lung with mediastinum and the contents of each root
- Fissures: the oblique fissures as key functional anatomy in normal respiratory excursion of the lung substance
- Surface markings of the hila, lungs and fissures
- Lymph drainage via hilar, tracheobronchial and mediastinal groups/trunks
- Nerve supply - autonomic (and implications for bronchial stimulation and pain perception) and appreciation of central control of respiration

OSTEOLOGY

- Ribs: typical arrangement. The costal groove and its clinical implication
- Knowledge of the functional anatomy of the bony thorax to allow understanding of the way in which the typical and atypical ribs and sternum work as a functional unit in respiration. The clinical consequences of injury to the bony cage: flail chest

Section 4: Abdomen

Knowledge requirements focus on the applied anatomy of the abdominal wall and key internal structures. The detailed anatomy of individual organs is not required but aspects of importance are highlighted below for specific study.

Knowledge of the development of the gut (growth, movement, rotation) is not explicitly assessed, but having overview knowledge of the topic facilitates understanding of the arterial supply and lymph drainage of the gut which may aid your learning.

Bear in mind that knowledge of the cross-sectional anatomy of the abdomen as revealed by CT is highly important in determining the extent of injury or disease. You should make every effort to familiarise yourself with normal and common abnormal cross-sectional CT films of the abdomen.

Abdominal wall:

- The standard regions of the abdomen and their lines of definition (e.g. epigastric, umbilical)
- External oblique:
 - Extent
 - Attachments
 - As the origin of the inguinal ligament
- Internal oblique: Extent
- Transversus: Extent
- Rectus abdominis: Extent
- The derivation of the aponeurosis between the two recti
- Nerve supply of anterior abdominal wall muscles
- Rectus sheath:
 - Derivation from the obliques
 - Contents:
 - Posterior intercostal nerves
 - Superior epigastric artery
 - Inferior epigastric artery
- Actions of the abdominal muscles:
 - Truncal movement
 - Rib depression
 - Visceral support

Inguinal region

- Knowledge of the inguinal region enables understanding of the basis of hernias as well as the procedural anatomy of line placement and regional nerve blockade
- Inguinal canal:
 - Position
 - Roof, walls and floor
 - Origin of the superficial inguinal ring
 - Origin of the deep inguinal ring
 - Anatomical relations of the nerves, arteries & veins in the inguinal region and the position of psoas

Testis, epididymis and spermatic cord

- Components of the spermatic cord: vas, vessels and 3 covering layers
- Appreciation of the gross anatomy of the testis: structure not required
- Blood supply as being derived from aorta via testicular artery in the cord
- Lymph drainage: differentiation from scrotal drainage pattern
- Descent pathway: derivation of undescended testis & indirect inguinal hernias in infants
- Vas (ductus) deferens:
 - As being derived from epididymal canal
 - As a component of spermatic cord
 - Its course through to prostatic urethra
- Nerve supply of testis and epididymis

Topography of the abdominal cavity

Note: Knowledge requirements for this section relate to the anatomical implications of injury to the cavity

- Appreciation of those abdominal organs possessing free mesenteries and those bound to the posterior abdominal wall
- Retroperitoneal vs intraperitoneal structures
- The implications of the above concepts for likelihood and patterns of injury following abdominal trauma and decelerative forces
- A detailed knowledge of the sacs, compartments and peritoneal folds of the abdomen is NOT required

Peritoneum

Note: Knowledge of the compartments, ligaments and sacs is of direct relevance in relation to abdominal ultrasonography. Assessment at MCEM level will not assume any experience of the technique.

- Parietal and visceral peritoneum as a serous membrane; functional differences of the two
- Knowledge of the peritoneal folds and the greater and lesser sacs is not required
- Concept of the supracolic, infracolic and pelvic compartments
- Infracolic compartment
- The transverse mesocolon as the division between this and the supracolic compartment
- Primary components of the right and left infracolic compartments
- The small intestinal mesentery: anatomical attachments (root) and role of encapsulated mechanoreceptors
- The sigmoid mesocolon: anatomical attachments
- Supracolic compartment
- Appreciation of its position largely under cover of the costal limits of the thoracic cage
- Greater omentum:
 - attachment around oesophagus, greater gastric curve and duodenum
 - its extent across the abdomen
 - its function

Knowledge of the lesser sac is NOT required

Gastrointestinal tract

Abdominal oesophagus

- Its anatomical landmarks (eg diaphragmatic opening at level of 7th costal cartilage) at both its diaphragmatic and gastric limits and the factors guarding against gastric reflux
- Anatomical relations in terms of the consequences of oesophageal rupture or penetration

Stomach

- The anatomical distinctions of fundus, body & pylorus: role of the pylorus in the digestive process
- Relations of the stomach: Diaphragm; greater omentum; spleen; transverse mesocolon. Implications for local spread of disease
- Arterial supply as being derived from the 3 branches of the coeliac trunk. Detailed knowledge of the arterial supply not required, but see below for note regarding vasculature of the alimentary tract
- Nerve supply: appreciation of the importance of vagal parasympathetic input via the anterior & posterior trunks and their main branches

Small intestine 1: duodenum

- Relation to aorta, pancreas & inferior vena cava
- Its largely retroperitoneal position and division into 4 parts: the vertebral levels corresponding to these divisions. Detailed relations of each section are NOT required
- Blood supply from the pancreaticoduodenal arteries

Small intestine 2: jejunum, ileum

- Anatomical position within free mesenteric margin: implications for injury
- Meckel's diverticulum as a site of potential ulceration / perforation
- Innervation: the importance of sympathetic supply from spinal segments T9/10 in referred pain
- Blood supply as being derived from the (midgut) superior mesenteric artery

Large intestine 1: Caecum

- Position on peritoneal floor of right iliac fossa: implications of local relations (eg psoas fasciae & femoral nerve) for disease
- Position of appendix & common positional variants of its tip: McBurney's point

Large intestine 2: colon

- Position of the ascending, transverse & descending colon in relation to abdominal organs
- Appreciation of the mesentery and implications of arterial blockade for ischaemia or infarction
- Arterial supply as being derived from the (hindgut) inferior mesenteric artery
- Innervation: sympathetic supply from spinal segments T10-L2 & implications for referred pain

Liver & biliary tract

- Surfaces, relations and features of the liver
- Surface marking
- The liver lobule as an architectural building block: function of the lobule, vessels, sinusoids
- The named four lobes of the liver: appreciation of their functional division into two halves. Detailed anatomy of lobes and segments not required
- The shape of the liver: presence of visceral & diaphragmatic surfaces
- Principal relations of the diaphragmatic surface (eg diaphragm, lungs, pleura). Position of vena cava and other key structures (eg porta hepatis) in relation to the gross structure of the liver. Detailed knowledge of relations not required
- The hepatic veins & IVC as providers of organ stability
- Blood supply via hepatic artery (and overview of its divisions) and portal vein: anatomical basis of the potential for one-sided liver infarction. Pattern of venous return
- Lymphatic drainage pattern and implications for spread of carcinoma

Gall bladder

- Gross structure, surface anatomy and principal relations
- Course of normal bile flow: location of Hartmann's pouch & implications for stone formation
- Details of histology, blood supply and lymph drainage not required

Biliary ducts

- Pattern of formation of common hepatic duct from tributaries
- The (common) bile duct as a 3-part tube: principal relations of each part and point of entry into ampulla of Vater
- Innervation: action of sympathetic & parasympathetic nerves in normal function. Basis of referred pain

Portal vein

- Appreciation of the five sites of portosystemic anastomosis and the implications of these
- Appreciation of the vein as being a continuation of the superior mesenteric vein & splenic vein
- Detailed anatomy of the portal vein NOT required

Pancreas

- Overview of the exocrine & endocrine function of the organ
- Surface marking
- Principal relations of the head, neck, body & tail
- Blood supply from the splenic artery (primarily): pattern of venous drainage & lymph drainage
- Innervation: basis of referred pain (T6-10)
- Developmental details are not required

Spleen

- Functional overview: surface markings
- Palpation of the enlarged spleen: anatomical basis of differentiation of splenomegaly from retroperitoneal masses
- Details of vasculature/ innervation/ development NOT required

Posterior Abdominal wall: muscles, vessels, nerves

General note

Required knowledge in this section focuses on those aspects of anatomy relevant to injury or disease in the emergency setting. A detailed knowledge of the course and many named branches of the abdominal aorta is NOT required, neither is knowledge of the course and relations of the IVC nor details of the umbilical, vitelline or cardinal veins.

Knowledge of the nerves of this region centres upon appreciation of the spinal nerve roots implicated in injury and disease. The detailed course of the individual named nerves (e.g. subcostal, ilioinguinal) is NOT required.

However, the prime importance of the femoral nerve mandates knowledge of its origin, position in the region and relations to psoas and iliacus.

Muscles

- Psoas major: appreciation of its wide attachment and intricate relation to local nerves. Innervation. Actions on hip joint
- Quadratus lumborum: Relations to psoas major & transversus: actions & innervation
- Iliacus: actions & innervation
- Appreciation that each of these 3 muscles possesses strong fascial coverings. Detailed local anatomy NOT required

Vessels

- Surface markings of abdominal aorta and inferior vena cava
- The abdominal aorta as having 3 groups of branches in this region (single ventral gut arteries, paired visceral arteries, paired wall arteries)
- Details of the named arterial branches (e.g. inferior phrenic) not required
- Inferior vena cava: primary tributaries (external iliac, lumbar, gonadal, renal, hepatic) and the areas drained by each

Nerves

- Branches of the lumbar plexus and the structures supplied by each of L1 - L4 (anterior & posterior divisions where applicable)
- Overview only of the arrangement of the sympathetic & parasympathetic supply to the abdomen. Anatomical knowledge of the lumbar sympathetic trunk, lumbar ganglia & coeliac plexus not required

Lymph nodes

- Arrangement of nodes into pre- and para-aortic groups. Structures draining to each

Kidneys, ureters and bladder

Note: anatomy of the suprarenals NOT required.

Kidney

- Position & palpable aspects of the normal kidney. Movement of the kidney during normal respiration
- Appreciation of the intimate relation of the kidneys to diaphragm, abdominal wall muscles, pleural sacs & peritoneum; contribution of upper left kidney to stomach bed. Implications of these relations in injury and disease. Detailed anatomy of these relations not required
- The renal fascia as a determinant of the spread of perinephric abscess pus and the anatomical basis for this
- The renal arteries as fast-flowing vessels posterior to the pancreas. The segmental nature of renal arterial supply
- Lymphatic drainage to para-aortic nodes
- Understanding of the basis for renal colic pain: role of coeliac plexus, sympathetic trunk & spinal nerves
- Overview of the renal architecture: components of the nephron; medulla; cortex. Renin-secreting cells
- Details of kidney development are NOT required

Ureters

- Surface marking both clinically and radiographically
- Understanding of the basis of colic pain: see kidney
- Developmental and structural details are NOT required
- The potential for right ureteric proximity to the appendix and its consequences in disease

Urinary bladder

- Understanding of the broad structure: apex, base, inferolateral & superior surfaces. Points of entry of ureters
- The bladder in full & empty states: implications for injury
- Overview of control of micturition: effect of injury or disease above S2
- The basis of bladder pain via the lateral spinothalamic tract (see also later sections)
- Developmental details NOT required

The pelvic cavity

- As before, knowledge requirements focus on the anatomical principles for the emergency management of injury & disease
- You should examine and revise the bony components of the pelvis and know each bone's name, articulations with its neighbours and position on radiographs of the normal pelvis
- Obturator internus & piriformis: requirements stated in gluteal section above

- Appreciation of the pelvic floor as a muscular sheet: details of the muscles not required
- Understanding of the actions of the pelvic floor in postural and contractile tonus
- Knowledge of the pelvic fascia NOT required

Rectum & anus

- Candidates must know the general and gender-specific structures palpable on per rectal digital examination anteriorly, posteriorly and on either side
- Appreciation of the fact that the rectum arises from the sigmoid colon where the mesocolon ends, at the third sacral piece, without structural differentiation
- The anorectal junction as the point where muscle gives way to sphincters supported by puborectalis
- Location of the rectovesical fascia and its role in determining anterior carcinomatous spread from rectal neoplasms
- Innervation: sympathetic & parasympathetic supply: pain transmission
- The anal canal as the last 4cm of the adult alimentary tract: overview of the mechanism of defecation & its nervous control
- Detailed knowledge of the external & internal sphincters, ischioanal fossa, perineal body, anococcygeal body and anal mucous membrane structure not required
- Lymph drainage: internal iliac & superficial inguinal (palpable in disease)
- Cutaneous innervation of the anal skin: utilisation of anal reflex in neurological assessment

Male internal genitalia: prostate

- Size of normal adult prostate & immediate anatomical relations. Its penetration by the proximal urethra
- Knowledge of the lobular structure sufficient to appreciate the anatomical basis of prostatic hypertrophy (benign or potentially malignant)
- Lymph drainage of the prostate: potential drainage to external iliacs and clinical implications if palpably enlarged
- Developmental details NOT required
- Anatomy of the vas (ductus) deferens & seminal vesicles NOT required

Female reproductive system

- Size and immediate prime anatomical relations (bladder, rectouterine pouch, ovary, intestine, ureter) of the adult uterus
- Division of the structure into fundus, body, cervix: detailed knowledge not required
- Uterine tubes: length, division into isthmus, ampulla, infundibulum. Locations of ectopic pregnancy
- Blood supply: the uterine arteries and their location in the broad ligament. Anastomosis with ovarian tubal arteries: implications for ectopic implantation
- Innervation of the uterus and tubes (not motor)

- Knowledge of the internal uterine structure and its musculoligamentous supports NOT required

Ovary

- Location and anatomical rationale for radiated pain to the medial thigh in disease
- Ovarian blood supply as derived from direct aortic branches
- Lymph drainage: para-aortic pattern, and additional potential for palpable inguinal lymphadenopathy in disease
- Innervation: to allow appreciation of the clinical presentations of ovarian pain
- Knowledge of the internal structure & development of the ovary NOT required

Vagina

- Size in the normal adult and immediate relations. Structures palpable on vaginal examination
- Details of blood supply, innervation & lymph drainage NOT required
- Knowledge of the anatomy of the female urethra is not required except for location of the opening into the vaginal vestibule

Male urogenital region

- It is important that candidates are aware of the anatomical complexity of the male urethra: this has implications in the management of pelvic trauma
- Although knowledge of the deep & superficial perineal pouches is not specifically required, understanding the nature of the perineal membrane & urogenital diaphragm allows a clearer understanding of the problems associated with damage to the male urethra
- Knowledge of the anatomy of the pudendal vessels and nerves is NOT required
- Specific knowledge requirements are shown below

Urethra

- Male urethra: its length in the adult. Division into prostatic, membranous & spongy parts
- Membranous urethra: anatomical extent, narrowness at the bladder neck, appreciation that it pierces the urogenital diaphragm
- Prostatic urethra: anatomical extent. Appreciation that it is the widest part of the tube
- Penile (spongy) urethra: anatomical extent, curvature, mucosal folds
- Penis & scrotum
- Scrotal lymph drainage and innervation (L1, S2, S3)
- Appreciation of the cross-sectional anatomy of the penis: relative positions of corpora, blood vessels and urethra
- Penile innervation (S2)

Stability of the pelvis: joints and ligaments

- Appreciation of the ligamentous factors enabling sacroiliac stability: locations of the sacrotuberous and sacrospinous ligaments
- Location of the iliolumbar ligament

- The sacrococcygeal joint: ligamentous stability

Lumbar and sacral plexuses

Where appropriate, mention has been made of key knowledge requirements in relation to the lumbar plexus. A detailed knowledge of the courses of the derived nerves is not required. Likewise, although it is important to know the six branches which arise from the sacral segments (eg pudendal S2, 3, 4), the anatomy of these branches is not required.

Specific named nerves which are required knowledge are:

- Sciatic (anatomical course and branches)
- Common peroneal (anatomical course and branches)
- Tibial nerve (anatomical course and branches in popliteal region & calf)

Section 5: Head and neck

Introductory comments

Key knowledge for the head and neck region relates to safe management of common injuries of the region, in particular the face. Appreciation of the anatomy of the neck facilitates an understanding of the causes of airway obstruction and the rationale for management of cervical spine injuries. There are several aspects of the anatomy of this region which are important to know in some detail, and some which are not required. These are highlighted throughout.

- General topography: muscles, spaces & fascia
- Appreciation of the topography in terms of:
 - Postvertebral extensor musculature
 - Pre-vertebral flexor musculature
 - Presence and function of pre-vertebral fascia
 - The visceral of the neck as lying anterior to the pre-vertebral fascia
 - The thyroid as being enclosed in pretracheal fascia
 - trapezius & sternomastoid as lying within deep cervical fascia
- Specific requirements: Deep cervical fascia as comprising 4 components (eg carotid sheath)
- [Knowledge of the anatomy of each fascial component not required]
- Tissue spaces of the neck: [prevertebral, retropharyngeal, parapharyngeal, submandibular]
- Their locations
- The common pathways by which infection may spread from each
- Anatomical basis of Ludwig's angina

Triangles of the neck: sternomastoid

- Overview of its attachments
- Nerve supply (spinal accessory esp C2-3)
- Actions (single muscle and action in pairs)
- Clinical test of the muscle

Triangles of the neck: anterior and posterior triangles

- Knowledge of the boundaries and contents of the triangles is not required as a stand-alone item of knowledge, though an appreciation of the topography of the anterior triangle will benefit understanding of the specific structures within it which are highlighted below.

Suprahyoid and infrahyoid muscles

- Concept of suprahyoids acting as effectors of swallowing; individual detail not required
- Concept of infrahyoids acting as laryngeal depressors; individual detail NOT required

Thyroid

- Structural overview: lobes, isthmus. Relations (lateral, medial, posterior)
- The position of the recurrent laryngeal nerve
- Attachment of isthmus to tracheal rings
- Blood supply - appreciation of risks of haemorrhage in trauma
- Lymph drainage pattern
- Developmental details not required
- Anatomy of the parathyroids not required

Trachea

(See also earlier sections)

- Its patency as being related to hyaline cartilage and trachealis
- Anatomical relations in the neck
- Landmarks for tracheotomy & tracheostomy

Oesophagus

(See also earlier sections)

- Anatomical relations

Carotid sheath

- See section on vasculature below: other details of its constituents not required

Neck

- Knowledge of the prevertebral muscles (recti, longus colli & capitis) not required except to appreciate that they act as weak neck flexors and lie beneath the prevertebral fascial layer

Cervical sympathetic trunk

- The superior, middle and inferior cervical ganglia as the components of the trunk
- Appreciation of the somatic branches via grey rami sequentially from the three ganglia to C1-8
- Appreciation of the visceral branches to the cardiac plexuses
- Appreciation of the vascular branches especially to dilator pupillae
- Anatomical basis for Horner's syndrome (see also later sections)

Root of the neck

- Scalenus anterior as a synergistic stabiliser of the neck: innervation from C5-6; attachments between C3-6 and the first rib
- Position of phrenic nerve across scalenus anterior: intimacy with the medial apex of the lung & vagus nerve
- Origin of right recurrent laryngeal nerve around subclavian artery
- Jugulo-omohyoid lymph node: location and role in drainage from tongue
- Subclavian vein: anatomical aspects of catheterisation in infraclavicular approach
- Subclavian artery: surface marking in the neck

Knowledge of the detailed relations of scalenus anterior in the root of the neck is not required except in reference to the specific points highlighted above. Likewise, knowledge of scalenus medius and posterior is not required.

Face

- Competent knowledge of facial anatomy is crucial to the safe management of injury and acute pathology. Failure to appreciate the anatomy can result in costly litigation.

Overview

- Facial muscle innervation as derived from the facial nerve (C7)
- Generalised arrangement of orifice sphincters and dilators

Eyelids

- Orbicularis oculi: position over frontal & zygomatic bones; innervation; actions
- Levator palpebrae superioris & occipitofrontalis: see below

Lips & cheeks

Orbicularis oris:

- Appreciation of its incisive & mental slips and the integration with buccinator
- Innervation & actions of orbicularis oris

Buccinator:

- Appreciation of its attachments to the jaws (detail not required); integration at modiolus
- Actions & innervation

Modiolus:

- Appreciation of its location & role in mastication
- Detail of the lip dilators (eg mentalis, risorius) not required

Facial nerve in the facial region

- Emergence via stylomastoid foramen
- Appreciation of the named five branches emerging from the parotid: structures supplied by each and effects of paralysis
 - Temporal
 - Zygomatic
 - Buccal
 - Marginal mandibular
 - Cervical

Sensory supply of the face

- Dermatomes of the face
- Named branches of the trigeminal nerve: appreciation of the anatomical basis of the clinical picture of herpes zoster / Sturge-Weber
- Ophthalmic nerve: named five cutaneous branches and territory supplied by each
- Maxillary nerve: named three cutaneous branches and territory supplied by each
- Mandibular nerve: named three cutaneous branches and territory supplied by each

Arterial supply of the face

- Facial artery as being derived from external carotid
- Appreciation of its tortuous course to the medial angle of the eye
- Superficial temporal artery: derivation from external carotid; surface marking

Venous drainage

- Appreciation that the facial vein communicates with the cavernous sinus
- Appreciation of the communication with the ophthalmic veins at the medial canthus
- Anatomical basis for cavernous sinus thrombosis: infections of upper lip & cheek

Facial lymph drainage

- Pattern of drainage: submental, submandibular, preauricular

Scalp

- Occipitofrontalis: attachments, innervation & actions
- Arterial supply:
 - Appreciation of a rich anastomosing network between external & internal carotid branches
 - Appreciation of profuse bleeding from scalp wounds due to the deep dermal attachments of the arteries in this region
 - Named individual arterial territories (eg for posterior auricular artery) not required
- Venous drainage:
 - Appreciation that veins accompany arteries
 - Communication between posterior auricular vein with mastoid vessels from sigmoid sinus: clinical implications
- Innervation:
 - Territories of occipital, auriculotemporal & zygomaticotemporal nerves
- Temporal fossa:
 - Location in terms of temporal lines & zygomatic arch
 - Bony components of the zygomatic arch
 - Appreciation of the vulnerability of key nerves in the fossa.
- Temporalis: attachments, innervation & actions

Parotid region

- Masseter: attachments (overview-as being attached to zygomatic arch & mandible), innervation, actions

Parotid gland

Its anatomical location

- Awareness of its strong capsular covering (sheath) and clinical implications in gland swelling
- Knowledge of the relations of each surface NOT required
- The structures embedded in the gland: nerves (see above), artery, vein
- Parotid duct: anatomical course via masseter & buccinator; location of orifice
- Secretomotor innervation of the gland: preganglionic & vasoconstrictor pathways

Infratemporal fossa

- Overview only of the location of this region beneath the skull base between pharynx & mandible
- Appreciation of the key contents of this region: pterygoids, pterygoid plexus, mandibular nerve

Pterygoids

- Appreciation of their role in opening the mouth (esp lateral) & chewing (medial)
- Detailed anatomy of their attachments & heads not required

Maxillary artery

- Appreciation of its derivation from external carotid (see also superficial temporal above)
- Overview only (detail not required) of its many branches to local bone, ear, tympanum, nose & palate

Pterygoid venous plexus

- Appreciation of potential injury in the administration local dental anaesthetics
- Drainage pattern: via maxillary veins to retromandibular vein
- Connections to deep facial vein/ cavernous sinus & inferior ophthalmic veins: clinical implications (see also face, above)
- Knowledge of sphenomandibular ligament & mylohyoid nerve not required

Mandibular nerve

- Anatomical course via middle cranial fossa, foramen ovale to region of lateral pterygoid
- Appreciation of division into anterior & posterior trunks (branches not required but see below)
- Specific knowledge required
- Auriculotemporal nerve: territory supplied
- Inferior alveolar nerve: territory supplied
- Lingual nerve: territory supplied
- Chorda tympani: role in taste sensation

Carotid sheath

- Knowledge of the structures within the sheath and their local relations is NOT required

Glossopharyngeal nerve

- Appreciation of its emergence from the jugular foramen
- Branches of the nerve: Overview only of its supply to middle ear (sensory), parotid (secretomotor), carotid sinus, pharynx, tonsils and tongue

Vagus nerve

- Appreciation of its emergence from the jugular foramen
- The contribution of the accessory nerve to forming the nucleus ambiguus and the role of these fibres
- Branches of the nerve: Overview only of its supply to ear, pharynx, hypopharynx, larynx and cardiac plexus

Accessory nerve

- Appreciation of its emergence from the jugular foramen
- Its dual cranial (see vagus above) and spinal roots: territory of supply of spinal root

Hypoglossal nerve

- Appreciation of its emergence from hypoglossal canal
- Territory of supply: tongue

Maxillary nerve

- Appreciation of its emergence from the foramen rotundum (sphenoid)
- Its territory of supply

Pterygopalatine fossa

- Knowledge of the fossa and its contents is not required except for knowledge of the fact that sensory, secretomotor and sympathetic innervation of the nose and palate are derived from the pterygopalatine ganglion which sits within this fossa: potential for local clinical effects in trauma or disease

Nose and paranasal region

Function

- Overview only of the rationale for ciliated epithelial lining of much of the cavity

External nose

- Cutaneous innervation
- Blood supply as being derived from branches of ophthalmic and facial arteries in particular

Nasal cavity

- Constituents of the floor & walls: the conchae (turbinates)
- Appreciation of the potential role of the inferior turbinate in causing nasal swelling
- Position & function of nasolacrimal duct

- Appreciation (anatomy not required) of the ostia from the maxillary sinus & ethmoidal air cells
- Lateral wall: blood and nerve supply
- Septum: blood and nerve supply: contributing vessels to Little's area
- Detailed osteology of the nasal region NOT required
- Details of nasal lymph drainage NOT required

Paranasal sinuses

- Overview of the arrangement of the sinuses as paired structures
- The locations of the maxillary, ethmoidal, frontal & sphenoidal sinuses on plain radiographs
- Appreciation of the developmental staging of sinus appearance from age 6-7yrs onwards
- Detailed knowledge of the innervation, blood supply and lymph drainage of the sinuses is NOT required

Mouth and hard palate

Mucous membrane and gingivae

- Sensory innervation

Teeth

- Normal adult dentition and the approximate age at which adult teeth erupt
- Innervation of the upper & lower teeth: positions for effective anaesthetic infiltration
- Overview only of the tooth structure: basis of the pain of tooth disease

Oral cavity

- Components of the hard palate
- Blood supply, sensory innervation & lymph drainage pattern of the hard palate
- *See also later section on pharynx*

Tongue

- Overview only of its structure and the differences between the anterior and posterior elements
- Details of the individual component muscles (eg hyoglossus) is NOT required
- Lymph drainage: clinical significance of the crossover drainage pattern to the cervical nodes
- Overview only of the sensory innervation of the tongue as being derived primarily from lingual & glossopharyngeal nerves
- Overview only of the taste pathway
- The development of the tongue and the anatomy of tongue movement are NOT required

Floor of the mouth

- Knowledge requirements limited to an appreciation of the muscular nature of the floor, comprised in the main of tongue, and the fact that the submandibular duct, hypoglossal nerve, lingual artery & nerve, glossopharyngeal nerve and sublingual gland either end or are situated in the floor of the mouth

Muscular pharynx

- Appreciation of its location as being between the skull base and oesophagus (C6 level)
- The relation posteriorly to prevertebral fascia & the potential for spread of local infection

Muscles

- Overview of the structure as being three sheet-like constrictor groups which act in concert in swallowing
- Detailed knowledge of each constrictor and other small component muscles (eg salpingopharyngeus) is NOT required
- Lymph drainage: deep cervical groups
- Motor supply for swallowing: pharyngeal plexus of vagus, glossopharyngeal & sympathetic fibres
- Sensory mucosal supply: maxillary (nasal portion), glossopharyngeal (oral), laryngeal

Interior of pharynx

- Appreciation of its arrangement into nasal, oral & pharyngeal parts acting as a continuum
- Location of the adenoids
- Location of the opening of the auditory tube
- Location of the (palatine) tonsils
- Appreciation of the vascularity of the tonsillar bed: intimate arrangement of facial & internal carotid arteries
- Location of external palatine vein: role in local haemorrhage
- Tonsillar lymph drainage: deep cervical group

The valleculae: location

Laryngeal region of pharynx

- This region is especially important as it contains the laryngeal inlet & piriform fossae. Candidates will be assumed to possess sufficient anatomical knowledge to be able to identify the key structures of this pharyngeal part as viewed via direct laryngoscopy

Soft palate

- Appreciation of its composition as a soft functional structure comprising paired muscles
- Details of the individual muscles (e.g. tensor palati) is NOT required

Uvula

- location & composition (mucoglandular)

Innervation

- pharyngeal plexus (motor)
- pterygopalatine ganglion (secretomotor)
- maxillary division of V (sensory)

Gag reflex

- appreciation of the causal pathway via glossopharyngeal (afferent) & vagus (efferent) nerves

Larynx

- Appreciation of its anatomical location as being inferior to hyoid and blending with the trachea at C6 vertebral level

Skeletal framework

- Appreciation that the skeleton comprises single & paired cartilages, joints, ligaments and membranes
- Cartilages: the names and relative locations to neighbours of the thyroid, cricoid, epiglottic & arytenoid cartilages
- Joints: the cricothyroid & cricoarytenoid joints as the two prime laryngeal joints effecting normal function
- Membranes & ligaments: appreciation that a series of membranes contribute to laryngeal structure
- Cricothyroid membrane (conus elasticus): surface marking and role in emergency airway management

Note that a detailed knowledge of laryngeal skeletal anatomy is not required for MCEM except for the points highlighted above. However, clinical airway management is greatly facilitated by the study of an articulated larynx and trainees are strongly encouraged to examine a prosected or artificial model in order to consolidate their basic anatomical knowledge.

Laryngeal muscles

- Appreciation that the musculature is functionally divided into intrinsic & extrinsic groups; the role of each group

Intrinsic muscles

- Appreciation that these muscles alter the size & shape of the inlet and also move the vocal folds
- A detailed knowledge of individual muscle names (eg thyroepiglottic, transverse arytenoid) and actions is not required

Intrinsic laryngeal movements

Appreciation that there are four principle functional roles of the larynx:

- Phonation
- Sphincteric
- Coughing
- Breath-holding whilst straining (vocal cord adduction)

Innervation

- Role of the recurrent laryngeal nerve in supply to the intrinsic muscles
- The clinical effects of partial & complete recurrent laryngeal nerve paralysis
- Details of the supply to the mucous membrane and of laryngeal blood supply are NOT required

Extrinsic muscles

- Appreciation of the need for elevators & depressors to effect swallowing: individual muscle names & actions not required

Orbit and eye

Bony orbit

- Constituent bones of the orbital margin
- Knowledge of the detailed anatomy of the orbital walls is not required

Eyelids

- Appreciation of their composition as being one of orbital septum blending into tarsal plates
- Location of the Meibomian glands
- Innervation

Conjunctiva

- Appreciation of its composition as being primarily one of fibrous tissue and stratified squamous epithelium
- Innervation

Lacrimal apparatus

- Appreciation that this comprises glands, canaliculi, duct and sac
- Location of the lacrimal glands (lateral orbital roof)
- Location & function of the lacrimal sacs
- Location & function of the nasolacrimal ducts

Orbital muscles

- Overview of the anatomical arrangement of the muscles: the cone of orbital muscle
- The functions and innervation of each of the following named muscles:
 - Superior rectus
 - Medial rectus
 - Inferior rectus
 - Lateral rectus
 - Superior oblique
 - Inferior oblique

Orbital stability:

- Anatomical factors exerting anteroposterior eye stability (eg bony attachment of the recti)

Orbital nerves:

(See also Face above)

Optic nerve

- its emergence through the sphenoidal optic canal with the ophthalmic artery
- Appreciation of its composition as an outdrawing of white matter with a subarchnoid space
- Understanding of this fact as the reason for the appearance of papilloedema in raised intracranial pressure
- Blood supply of the nerve as being a combination of anterior cerebral, ophthalmic & central retinal arteries
- A detailed knowledge of the anatomical course of the many other nerves with a presence in the orbit (eg lacrimal, nasociliary) is NOT required.

Orbital blood supply

- Ophthalmic artery as the prime artery of local supply
- Appreciation (detail not required) that it supplies all the orbital muscles, the lacrimal gland & the eye

Orbital venous drainage

- Appreciation of the superior ophthalmic vein having communication with the cavernous sinus
- The additional role of the inferior ophthalmic vein

Orbital lymph drainage

- Overview of the drainage pathway as being to deep cervical nodes via the pre-auricular & parotid groups

Structural anatomy of the eye

- Overview of the derivatives of the eye: fibrous sclera/cornea, choroid, retina
- Sclera & cornea: function, innervation, pathway of the corneal reflex (via trigeminal ganglion)
- Choroid & ciliary body: function
- Control of pupillary size: appreciation that control is a balance of sympathetic & parasympathetic activity
- Anatomical basis of Horner's syndrome & Argyll-Robertson pupil should be understood
- Retina: Appearance on normal fundoscopy; optic disc as the entry point of the optic nerve; macula & fovea; blood supply
- Refractive media: overview [detail not required] of the arrangement of aqueous humour, chambers, lens & suspensory ligament

Functional anatomy of eye movement

- Control of conjugate gaze, causes of nystagmus & the vestibulo-ocular reflexes are not within the scope of the anatomy curriculum
- However, knowledge of the following aspects of eye function is required

Clinical effects of palsies of the III, IV and VI nerves

- Clinical effects of paralysis of a given extraocular muscle (eg superior rectus => diplopia on looking up)

Ear

- Structural overview: meaning of the terms external, middle and inner ear

External ear

- Pinna as a cartilaginous folded structure
- Innervation: great auricular & auriculotemporal nerves as prime innervators assisted by facial & lesser occipital nerves
- External acoustic meatus: adult length (3cm); innervation
- Tympanic membrane: functional overview; attachment of handle of malleus

Middle ear

- Its structure as being one of air-filled cells in the petrous temporal bone
- Its function as one of a converter of airborne vibrations to liquid-borne pulses: role of the ossicles
- Structural details of the tympanic cavity, ossicles & joints, innervation & vascularity not required

Auditory tube & mastoid antrum

- Appreciation of auditory tube as a connection between nasopharynx & mastoid air cells of the temporal bone
- Detailed tubal anatomy (eg bony vs cartilaginous parts, blood supply) not required
- Mastoid antrum & air cells: location, anatomical significance of venous drainage in spread of sepsis

Internal ear

Overview only of the role of the inner ear as the mediator of:

- Hearing: via cochlea
- Kinetic balance: via semicircular canals
- Static balance: via saccule & utricle
- Although a more detailed understanding of the interplay of these inner ear structures is helpful in the interpretation of inner ear pathology, the anatomy of the inner ear is not required for MCEM

Temporomandibular joint

The separate listing reflects its importance in mouth function.

Movements

- Appreciation of the movements possible: protraction/ retraction; passive and active opening; closing; grinding
- Its composition: synovial joint between mandibular head & squamous temporal bone
- The role of the lateral temporomandibular & sphenomandibular ligaments in stability
- Comparative stability of the joint in open vs closed positions
- Role of the pterygoids, digastric, temporalis & masseter in joint function

Vertebral column: bones, joints, muscles

A working knowledge of the anatomy of the vertebral column is essential for the correct interpretation of clinical symptoms & signs. Candidates are advised to revise the anatomy of this region by reference to an articulated vertebral column or at least a virtual computer-based model.

- Note that knowledge of the blood supply of the vertebral column is not required
- Structural overview: general terminology of body, lamina, pedicle, articular processes and their locations on a typical vertebra
- Zones of the column: numbers of vertebrae in each zone (eg cervical, lumbar)

Vertebral joints

- Appreciation that adjacent vertebrae are held together by discs and anterior & posterior longitudinal ligaments
- Annulus fibrosus as a fibrous ring enclosing the gelatinous nucleus pulposus
- Appreciation of the anatomical rationale for herniation of the nucleus pulposus being predominantly posterior
- Anatomical basis of the way in which spinal nerve roots are irritated by herniation (the "one below" nerve root pattern)
- Attachments of each of the anterior & posterior longitudinal ligaments
- Role of the ligamenta flava, supraspinous, interspinous & intertransverse ligaments

Vertebral column (*see also muscles below*)

- Appreciation of the possible planes of movement: flexion, extension, lateral flexion
- Appreciation of the fact that rotation occurs predominantly in the thoracic column

Atlas & axis

- Main anatomical differences between these two bones: lack of centrum in atlas; dens & bifid spinous process of axis
- Role of atlanto-occipital and atlanto-axial joints in permitting free head movement
- Cruciform ligament as the prime stabiliser of the dens; appreciation of the clinical effects of ligamentous damage

Muscles of the column

Detailed knowledge is not required. However, an overview of the mechanics of vertebral movement is required as listed below:

- Flexion of the column is provided predominantly by rectus abdominis assisted for rotation by the obliques
- A posterior mass of longitudinal extensor muscle runs the length of the vertebral column
- This muscle mass is termed erector spinae but actually comprises several different constituent muscles
- Innervation of erector spinae is via segmental posterior spinal root rami

Vertebral canal

- Appreciation of its anterior, posterior & lateral boundaries
- Its contents: spinal meninges, cord and nerve roots
- Appreciation that the bony walls are separated from the meninges by the epi (extra) dural space
- Appreciation of the fact that the spinal meninges consist of dura, arachnoid & pia
- Appreciation of the communication between the spinal subarachnoid space & that of the posterior cranial fossa
- The conus medullaris as the point below which the canal contains only the cauda equina & filum terminale
- Clinical landmarks for lumbar puncture; anatomical basis of the characteristic "give" of the needle

Section 6: Central Nervous System

Overview

Detail in relation to Central Nervous System (CNS) anatomy is limited to those aspects highlighted below. You should be aware, however, of the general structural arrangement of the brain and spinal cord.

The cerebral hemispheres essentially constitute the developed forebrain. The midbrain contains an aqueduct and acts as a connection to the hindbrain (pons, medulla oblongata and cerebellum). The cavity of the hindbrain is the fourth ventricle. The brainstem comprises the midbrain, pons and medulla. The medulla passes via the skull's foramen magnum to form the spinal cord, from

which cervical nerve roots emerge. CSF forms within ventricular choroid plexuses and exits via the foramina in the roof of the fourth ventricle.

Cerebral hemispheres

- Appreciation of the arrangement of a cortical covering of grey matter (cerebral cortical cells) and internal cell groupings including basal nuclei and thalamus. The gyri and sulci as structural features (names not required) and an appreciation that larger sulci are used as denominators of regions:
 - Frontal lobe – anterior to central sulcus and above the lateral sulcus
 - Parietal lobe – behind central sulcus and above lateral sulcus
 - Temporal lobe – below lateral sulcus
 - Occipital lobe – below parieto-occipital sulcus
- Structural aspects of the cerebral hemispheres
- Detailed anatomy of the sulci and gyri to be found on each of the main surfaces of the cerebral hemispheres is not required. Specific knowledge requirements are listed below
- Basal nuclei (basal ganglia): position within the lateral forebrain and function as a supraspinal control centre for skeletal muscle movement
- White matter: component fibres – commissural, arcuate and projection – and the role of the projectional fibres in making up the internal capsule
- Internal capsule: detailed anatomy (eg limbs, genu) not required, but an appreciation of its position and the significance of haemorrhage or thrombosis in this region
- Corpus callosum: its composition from commissural fibres; role as connector of symmetrical parts of the hemispheres

Cortical areas

- Appreciation of the key areas within which bodily function is determined is a fundamental part of the rationale for knowledge of CNS anatomy. The effects of traumatic and atraumatic brain lesions can be predicted based upon a working knowledge of the likely clinical signs, and this works in reverse such that typical neurological presentations infer typical areas of central damage.
- The following specific examples are required knowledge. You should be aware of their anatomical site and functions:
 - Broca's area
 - Wernicke's area
 - Auditory area
 - Visual area (*see also below*)

Visual fields and pathways

- A competent knowledge of the anatomical basis of vision is important. Knowledge is expected of the key components of the visual axis and the role of each in the generation of normal vision.
- Note that there is a separate section on key cranial lesions at the end of this section.
- Retinal bipolar and ganglion cells
- Optic nerve

- Optic chiasma
- Optic tracts
- Optic radiation and geniculate bodies
- Visual cortex
- Blood supply of the optic tract, chiasma and nerves.

Olfactory pathways

- Knowledge NOT required

Limbic system

- Knowledge NOT required

Ventricles

- A working knowledge of the anatomy and function of the ventricular system is key to understanding the clinical effects of pathology within the cranial cavity
- The ventricles are the source of CSF. CSF is secreted by the choroid plexuses, which are vascular conglomerates of capillaries, pia and ependyma cells. The bulk of CSF arises from the plexuses of the lateral ventricles
- In cross sectional radiology, the midline cavities (3rd, 4th ventricles and the aqueduct) are symmetrical, but the lateral ventricles (the cavities of the hemispheres) are not
- Key required knowledge is listed below:
 - Lateral ventricle as a C-shaped cavity: the divisions of the cavity into a body, anterior, inferior and posterior horns
 - The interventricular foramen (of Monro) as the communication to the 3rd ventricle
 - Third ventricle as a slit-like space in the sagittal plane; the location of the hypothalamus below the ventricle and its key functions
 - Fourth ventricle as lying around the pons and upper medulla. Detailed anatomy in relation to its pontine and medullary parts, and apertures and recesses, is not required

Thalamus

- Knowledge of the thalamus as collective cell groups (nuclei) and its key roles
- Anatomical location as a wedge-shaped structure around the 3rd ventricle
- Detailed anatomy (eg surfaces & their relations) is NOT required

Cerebral blood supply

- Appreciation of the role of the internal carotid and vertebral systems: the significance of the end-artery structure to vessels entering the brain surface in terms of occlusion
- Awareness of the anatomical basis (see below) of the clinical effects of occlusion of each of the main 3 cerebral arteries
- Arterial circle (of Willis): position around the optic chiasm: significance of the anastomotic potential of the circle and the significance of the circle as a source of subarachnoid bleeding

- The anterior & middle cerebral arteries as branches of the internal carotid; posterior cerebral as a terminal branch of the basilar
- Appreciation of the fact that anastomoses occur between the branches of the 3 cerebral arteries across the pia

Internal carotid artery

- Route of entry into the cranial cavity; as the source of the ophthalmic artery; as the source of the posterior communicating artery as well as two cerebral arteries

Middle cerebral artery

- Its susceptibility to embolism; appreciation of its role in supply of contralateral sensorimotor areas, and auditory and speech areas

Anterior cerebral artery

- Appreciation of its connection across the midline via the anterior communicating artery; appreciation of its areas of supply in terms of the clinical effects of interrupted flow

Posterior cerebral artery

- Appreciation of its key role in supply of the visual areas; anatomical basis of macular sparing in posterior cerebral thromboembolic disease

Cerebral venous drainage

- Details of the names and course of the cerebral veins (eg inferior anastomotic, deep middle cerebral) are not required, however the fact that venous drainage occurs via superficially-situated veins within the arachnoid should be understood

Brainstem

General comments

This area comprises the midbrain, pons and medulla. It extends from the tentorial aperture to the level of C1. The medulla passes out via the foramen magnum and becomes the spinal cord as C1 roots emerge

Anatomy I: nuclei

- The cells of the brainstem are predominantly clumped into nuclei. The locations of these nuclei within the brainstem are not required
- You should be aware, however, of the named nuclei which lie within the brainstem and their roles in motor, sensory and somatic innervation.

These are listed below:

- Oculomotor
- Trochlear
- Trigeminal
- Abducent
- Facial
- Vestibulocochlear
- Glossopharyngeal
- Vagus
- Accessory
- Hypoglossal

Anatomy II: midbrain

- The midbrain lies predominantly within the posterior cranial fossa. The aperture in the tentorium cerebelli lies on its dorsal surface. Details of the external appearance and relations of the midbrain are not required
- Blood supply: posterior cerebral and superior cerebellar arteries (ex-basilar)
- Appreciation that dopaminergic cells sit within the midbrain within the substantia nigra and that loss of dopaminergic neurons is the basis of Parkinson's disease

Anatomy III: pons

- Detailed anatomy is not required but an awareness that the pons houses the nuclei of the motor part of the trigeminal nerve, the abducent nerve and vestibulocochlear nuclei allows prediction of the clinical effects of a pontine haemorrhage
- Blood supply: pontine branches from the basilar artery

Anatomy IV: medulla oblongata

- This is the upward continuation of the spinal cord
- Again, detailed local anatomy is not required. Required knowledge is listed below:
- Blood supply: posterior inferior cerebellar arteries and branches of the vertebral and basilar arteries
- Anatomical basis of the 'medial medullary syndrome' and 'lateral medullary (PICA) syndrome'

Cerebrospinal fluid

- Its source via choroid plexuses has been mentioned. Total CSF volume is about 130ml of which the majority is in the subarachnoid space. Circulation / resorption is a dynamic process involving the arachnoid granulations
- There is small but significant CSF drainage via the cribriform plate of the ethmoid into the nasal tissues and the importance of this in head trauma should be understood
- The roles of the CSF in physiological terms should be understood

Cerebellum

- The detailed anatomy of this structure is not required. It sits in the posterior cranial fossa. Its functional significance should be understood. Postural reflexes, truncal stability and synergistic muscular movements all depend upon an intact cerebellum. Cerebellar lesions do not cause paralysis but do lead to disturbance of balance and movement
- Knowledge of the blood supply of the cerebellum facilitates understanding of the clinical effects of occlusion. Interruption of flow through any of the following will lead to 'cerebellar signs':
 - Posterior inferior cerebellar
 - Anterior inferior cerebellar
 - Superior cerebellar

Spinal cord anatomy

- Knowledge of the key anatomical elements of the cord is fundamental in clinical practice
- Extent

At birth, the conus medullaris lies at L3. By the age of 21, it sits at L1 or 2.

- Enlargements
 - Cervical (for brachial plexus) and lumbosacral (for lumbar & sacral plexuses). These sit at the vertebral levels of C3-T1 (cervical) and T9 to L1 (lumbosacral)
- Spinal nerve roots
 - Rootlets emerge from the cord in the subarachnoid space and amalgamate shortly afterwards into roots
 - Anterior & posterior roots then emerge from their individual intervertebral foramina. After invaginating the dura they combine into mixed spinal nerves which then go off to their respective destinations
 - The cord is shorter than the space available to it: below L1 level, the roots pass down near-vertically to form the cauda equina
 - The lower a nerve root, therefore, the more steeply it slopes down before gaining its intervertebral foramen: this is an important anatomical fact when interpreting potential clinical signs in spinal trauma
- Internal anatomy
 - The cross-sectional anatomy of the main features of the cord should be known and understood as listed below
 - Disposition of the cord into grey and white matter
 - Grey matter as cell body collections; white matter as fibres
- The locations of the important white matter tracts
 - Gracile / cuneate
 - Lateral corticospinal
 - Anterolateral
 - Spinocerebellar
- Projectional tracts: impulse transmission
- Appreciation of the ways in which afferent and efferent impulses are conveyed; the clinical effects of decussation

The anatomical basis for clinical effects of division of the cord

- Complete transection
- Hemisection
- Central cord syndrome
- Anterior spinal artery syndrome

Cord blood supply

- Appreciation that the cord is supplied by a single anterior, and paired posterior spinal arteries, and the main territories supplied by these vessels

Section 7: Cranial nerve lesions

Knowledge of the anatomical basis for the clinical effects of lesions of the cranial nerves reinforces the need to know key anatomy in everyday practice. For each of the following nerves, an appreciation of likely causes of disease or injury, the common clinical effects, and the anatomical rationale for these, is required. In particular, knowledge of the effects of interruption of the optic nerve along its course from retina to radiation is required:

- Olfactory
- Optic – chiasma, tract and cortical damage and the clinical effects
- Ocular palsies
- Trigeminal
- Facial – commonest of all cranial nerve lesions
- Vestibulocochlear
- Glossopharyngeal
- Vagus
- Accessory (spinal part)
- Hypoglossal

2. Summary of the physiology curricular content

Important note

The content of this curriculum is based upon a national consensus project. By learning the items detailed below, you will develop a broad and appropriate knowledge of applied physiology for emergency medicine.

Questions within the Membership Examination of the College (MCEM) will be based on this document. If you are familiar with the contents then you will be able to approach the physiology questions within MCEM with confidence.

Physiology textbooks

Many physiology textbooks are available and most of them are large and detailed.

For MCEM purposes, *Physiology at a Glance* (Ward, Clarke & Linden, Blackwell Science 2004) provides an appropriate level of detail. You may wish to refer to a larger text or web resources for clarification of specific items, but your own background and learning style will influence this.

Outline of this core curriculum

The content is arranged in six systems-based sections. You will find your own method of learning the detail, but remember that the important principle is the *applied* nature of physiology. Look for correlations between this important basic science and the clinical presentations you encounter daily in the Emergency Department. Not only will you learn the physiology more effectively, you will develop a richer understanding of the basis of disease and its management.

Review and corrections

This curriculum is subject to periodic review to ensure that it meets its educational objectives. If you have any comments to make in relation to the accuracy or terminology of its content then please contact us at the College and we will be happy to hear from you.

Section 1: Basic Cellular Physiology

Homeostasis

Appreciation of the fundamental role of homeostatic mechanisms in physiology:

- Negative feedback via receptors, comparators & effectors based upon a 'set point'
- The 'set point' as being a narrow range of values within which normal function occurs
- The principle of oscillations within the feedback loop based upon lag time in feedback
- Positive feedback as an amplification process: its instability and consequences of this
- The role of homeostasis in protecting the form and function of proteins

- Consequences of the loss of this protective role upon protein function
- **Compartments and fluid spaces in health**

Osmosis

- Definition
- Its importance as the transport mechanism for water based upon gradients
- Iso- hypo- and hyper-tonicity:
- Differences between each and consequences of ingestion of fluids of each type

Osmolarity and osmolality

- Differences between each
- Fluid spaces
- Relative distribution between intra- and extra-cellular spaces
 - Key differences between ECF and ICF in terms of cationic concentrations
 - Role of Na-K ATPase activity in maintaining ionic gradients between ECF and ICF
 - The Donnan equilibrium influencing movement of chloride ions

Plasma contents

- Basis of oncotic pressure (large proteins)

Key aspects of cell structure and function

A basic understanding of the roles of:

- Mitochondria
- Nucleus
- Endoplasmic reticulum and Golgi apparatus
- Lysosomes

Membrane structure

- The bilayer structure embedded with transport proteins
- The importance of G-protein coupled receptors in activation of cellular activity
- Note: A detailed knowledge of the G-proteins (s, i, q) is NOT required

Membrane transport

- An understanding of the functioning of the Na-K ATPase transporter (sodium pump)
- Appreciation that the sodium pump acts to move ions against concentration gradients
- The principle of ion channels controlled by electrical or ligand gating

Vessel fluid dynamics

Permeability

- Its relation to membrane characteristics and diffusion coefficients
- Note: knowledge of the detail of Fick's law is NOT required

Tube flow

- Its relation to pressure differences, tube length and radius, and substance viscosity

- Implication of small changes in radius upon flow rate
- Laminar vs turbulent flow and the clinical implications of turbulence within a vessel
- Note: knowledge of the detail of Poiseuille's law is NOT required

Wall tension

- Its relation to tubal wall thickness and radius
- Clinical implications of disruption to this relationship e.g. dilated cardiomyopathy

Blood and blood flow

Normal values

- Knowledge of normal adult values for Hb, haematocrit, platelet and white cell counts

Red blood cells

- Haemoglobin as the key component
- Erythropoietin (EPO) as the renally-produced stimulant to production
- Role of red marrow and spleen in production and sequestration

White blood cells

- Appreciation of their key role in immunity and defence against infection
- *Refer to pathology curriculum for additional required knowledge*

Plasma

- Albumin as a key binding protein and the major contributor to oncotic pressure

Platelets

- Role following vessel wall damage
- Importance of release of 5-HT and thromboxane A₂ in haemostasis
- Fibrin and thrombin's role in coagulation
- Detailed knowledge of the coagulation cascade is NOT required

Basis of the neurological action potential

- Membrane potentials as being a property of all cell membranes
- Resting membrane potentials as a consequence of asymmetric distributions of Na and K
- Note: detail of the specific ionic and voltage changes is NOT required
- Action potentials as being a property of excitable tissues

Appreciation of the ionic basis of the action potential

- Depolarisation
- Importance of the threshold potential in initiating propagation
- Propagation based upon the all-or-nothing principle
- Repolarisation
- Ionic basis of the absolute and relative refractory periods

Conduction of the generated action potential

- Saltatory conduction as a product of myelination spaced by nodes of Ranvier
- Importance of myelination in terms of speed and energy efficiency
- Relation between nerve size and conduction speed
- Note: knowledge of the classification of nerve fibres (A, B, I, II etc) is NOT required

Outline function of the sympathetic and parasympathetic nervous systems

You should cross-reference the principles here to the anatomy curriculum

- Appreciation of the autonomic nervous system as the effector component of homeostasis
- Principles of neurochemical synaptic transmission
 - Neurotransmitter vesicles and their role following Calcium release at the bouton
 - Post-synaptic [excitatory] and pre-synaptic [inhibitory] receptors
 - Role of cholinesterase, MAO and COMT in synaptic transmission

Principal effects of autonomic stimulation

- Key effects of sympathetic or parasympathetic stimulation upon body organs
- *Detail of these effects is covered later in specific cases in relation to systems*

Muscle physiology

Muscle morphologies

- An appreciation of the functional purposes of skeletal, smooth and cardiac muscle

Skeletal muscle

- Its composition [fasciculi, fibres, myofibrils] and the concept of functional units
- The sarcolemma and sarcoplasmic reticulum as prime membrane components
- Contraction as occurring via thick and thin filaments
- Simple understanding of excitation – contraction coupling as the basis of contraction
- Roles of calcium and ATP in effecting contraction
- Concepts of temporal and spatial summation, motor units and recruitment of units
- Detailed knowledge of contractile mechanisms (eg intracellular signalling) is NOT required

Cardiac muscle

- Functional differences from skeletal muscle
- Concept of electrical coupling in cardiac muscle cells
- Calcium release mechanisms
- Relation between length and tension (Starling relationship) in cardiac muscle
- Note: smooth muscle physiology is NOT required knowledge

Section 2: Respiratory physiology

Lung volumes and pressures

Knowledge and definitions of typical lung volumes for adults

- Tidal volume
- Vital capacity
- Residual volume
- Functional residual capacity
- Anatomical and alveolar dead space

Epithelial function in health

- Mucociliary clearance by ciliated columnar epithelial cells
- Mucus as a contributor to pathogen clearance (eg by use of antitrypsins)
- Clinical implications of increased or decreased mucous viscosity in the airways
- Roles of type I and type II alveolar pneumocytes
- *You should cross-reference the principles of lung volumes and pressures to the anatomy*

Lung compliance

- Compliance as a combination of static and dynamic factors
- Appreciation of the shapes of the static and dynamic pressure-volume loops
- Static compliance as a function of age, size and sex and its reduction in fibrosis
- Dynamic compliance as incorporating an airways resistance component

Alveolar interfaces

- Alveolar surface tension as a contributor to lung compliance via Laplace's law
- Surfactant as a tension-reducing phospholipid mixture secreted by type II pneumocytes
- Clinical consequences of reduced surfactant

Airway resistance

- Effects of autonomic activity upon airway smooth muscle
- Physiological basis of the clinical airway effects of asthma
- Peak expiratory flow rate: its dependence upon initial lung volume
- Appreciation of normal PEFV values for healthy adult males and females
- FEV(1)/ FVC as a composite measure of function [obstructive vs restrictive disease]
- Normal value of FEV(1)/FVC in a healthy adult

Gas transport

- Partial pressure as the contribution to barometric pressure exerted by that gas
- Normal partial pressure values of oxygen and nitrogen in ambient room air
- Henry's law as the determinant of the quantity of gas dissolved in a fluid
- Oxygen and carbon dioxide partial pressures in inspired, alveolar + expired air

Alveolar diffusion

- Relation of gas flow to membrane area, permeability and partial pressure differences
- Transfer factor as an indicator of rate of gas transfer (detail of calculation not required)
- Clinical implications of reductions in membrane area and/ or thickness
- Limitations of gas transfer by diffusion (eg CO) or perfusion (oxygen)

Gas transport within the circulation

Oxygen

- Haemoglobin as a co-operative binder of oxygen molecules
- Relation between blood oxygen content and PO_2 (oxygen dissociation curve)
- Factors shifting the dissociation curve to the left or right (pH, PCO_2 , temperature)

Anaemia

- Effects of low Hb upon arterial PO_2 and O_2 saturation and the dissociation curve
- Effects of HbF on the dissociation curve and the reasons behind this

Carbon dioxide

- Mode of transport of CO_2 within plasma
- Relation between CO_2 , carbonic acid and bicarbonate (detail of equation is required)
- Chloride shift and the buffering effect of haemoglobin
- Carbaminohaemoglobin as a contributor to CO_2 carriage

Control of respiration

Understanding of the principles of control

- Pontine
- Pneumotaxic centre
- Medullary receptor groups
- Lung receptors
- Voluntary control
- Voluntary control being via cortical motor neurones in pyramidal tract

Chemoreceptors

- Effects of rising CO_2 upon ventilation rate. Influence of metabolic acidosis or alkalosis
- Synergistic relationship between falls in PO_2 and rises in PCO_2
- Central chemoreceptors as the major determinants of CO_2 response
- Effect of blood PCO_2 upon CSF acidity hence upon central chemoreceptors
- Peripheral [carotid + aortic] chemoreceptors as minor determinants of response

Stretch receptors

- Vagally-innervated bronchial wall receptors
- Irritant receptors
- Role in irritant cough and airway constriction

J receptors

- Role in generation of tachypnoea due to odema, emboli or inflammation

Ventilation- perfusion relationship

V_a/Q mismatch types

- Effects of dead space and shunts on ventilation / perfusion gradients
- Shunts as lung regions with relatively low blood PO_2 and high PCO_2
- Effects of ventilation / perfusion mismatch upon arterial gas composition
- Limitations of additional inspired oxygen [FiO_2] upon shunts

- Potential gravitational clinical effects upon lung function in the elderly
- Anatomical right to left shunts
- Existence in health
 - Basis of clinical effects of large shunts in lung and / or heart disease

Section 3: Cardiovascular physiology

Systemic overview

Appreciation of how cardiovascular components are suited to their primary functions:

- Veins as thin-walled capacitance and return vessels
- Arteries as elastic pulsation–dampening distribution vessels
- Capillaries and venules as sites of exchange and return
- Normal adult values for total blood volume, cardiac output and stroke volume
- Mean arterial pressure [MAP] as (diastolic + one-third pulse) pressure and rationale for this
- Values of mean blood pressure before and after capillary beds and of the CVP

Cardiac cycle I

SA node as the originator of the cycle, modulated via autonomic nerves

- Activation of atrial myocytes via gap junctions and desmosomes
- Role of annulus fibrosus in limitation of excitation

AV node

- Relatively slow conduction in light of its small cells and purpose of this slowness

Propagatory fibres

- Bundle of His and Purkinje fibres as carriers of the depolarisation wave

Basis of the ECG

- Einthoven's triangle as a representation of voltages [leads I, II, III]

Cardiac cycle II

Pressures, volumes and key events through the cycle

- Atrial systole
- Isovolumetric contraction
- Ventricular ejection
- Isovolumetric relaxation
- Ventricular filling

Knowledge of the following is expected for each named phase above

- Chamber pressure [mmHg]
- Valvular opening / closure
- Relevant heart sound
- Relevant ECG deflection

Cardiac cycle III

Electrical basis of cardiac contractility

- Resting potential of myocytes and the trigger point for threshold
- Function of fast Na channels and Ca channels in shaping the cardiac action potential

SA node

- Absence of fast Na channels and implications of this

- Physiological basis of the pacemaker potential
- Effects of chronotropes upon potassium currents hence rate of contraction

Excitation – contraction coupling

- Fundamental role of calcium and its origin in sarcoplasmic reticulum
- Sequestration of calcium via Ca-ATPase and sodium/ calcium exchange pumps
- Biochemical basis of the Treppe effect

Effects of inotropes

- Effect of noradrenaline on calcium handling via beta-receptors
- Effects of digoxin (via Na pump) and of hypoxia (H/Ca competition) on calcium handling

Cardiac output

Relation of cardiac output (CO), heart rate (HR) and stroke volume (SV)

Frank – Starling relation between stroke volume and end diastolic volume

- Starling curve (*knowledge of the detail of this curve is required*)
- Implications of imbalance in the Starling relationship – pulmonary odema
- Baroreceptors as a determinant of CVP upon standing to correct the Starling relationship
- Implications of the Starling relationship for increased afterload

Peripheral vascular physiology I

Basis of vasoconstriction

- Appreciation of the role of G-protein mediated changes in intracellular calcium levels
- Implications of calcium-channel blocking drugs upon vasoconstriction
- Note: detailed knowledge of the vasoactive enzyme pathways is NOT required

Endothelial function

- Its role as a source of vasoactive mediators
- Stimuli to endothelial secretion

Peripheral vascular physiology II

Overview of the structure of the microcirculation

- Terminal arterioles, capillaries, lymphatic capillaries, postcapillary venules and venules

Transcapillary exchange

- Movement of lipophilic and hydrophilic substances
- Role of tight junctions, glycocalyx and pores in determining selective passage

Filtration

- Role of interstitial oncotic pressure and capillary hydrostatic pressure
- Physiological basis of the net filtration of water within a capillary bed
- Clinical effects of poor endothelial quality, low oncotic pressure and high venous pressure
- Role of lymphatics

Peripheral vascular physiology III

Local control of blood flow

- Range of pressures within which autoregulation occurs
- Basis of the myogenic regulatory response and the effects of local vasodilatory factors
- Role of potassium, carbon dioxide and adenosine in metabolic hyperaemia
- Effects of inflammatory mediators in altering microcirculatory dynamics (dilation)

Pulmonary flow

- Special arteriolar response to hypoxia (constriction) and its basis

Cutaneous flow

- Role of arteriovenous anastomoses in thermoregulation
- Contributory factors to enhanced local blood flow

Coronary flow

- Coronary metabolic hyperaemia as the basis of high oxygen extraction

Brain circulation

- Main components of blood-brain barrier
- Key roles of CO₂ and potassium in determination of cerebral autoregulation

Skeletal muscle flow

- Capillary recruitment via metabolic hyperaemia
- Role of skeletal muscle beds in generating total peripheral resistance

Section 4 Gastrointestinal physiology

Functional anatomy of the Gastrointestinal (GI) tract

You should cross-reference this section with the relevant portion of the anatomy curriculum

Outline structure of the gut wall

- Serosa
- Myenteric plexus
- Circular + longitudinal muscle layers
- Submucosal plexus
- Muscularis mucosa
- Lamina propria
- Mucosal layer

Saliva

- Sites of production, composition and functions in health
- Control of salivary secretion via taste (and additionally smell) receptors

Key physiology

Swallowing

- Phases (voluntary and reflex), control and functional anatomy of the swallowing process
- Function of the upper and lower oesophageal sphincters and of peristalsis

Stomach

- Overview of functions (storage, digestion, chyme regulation + intrinsic factor)
- Role of the chief and parietal cells
- The crucial role of the proton (H-K-ATPase) pump in hydrogen ion management
- Protective mucosal barrier mechanisms within the gastric lumen
- Secretion patterns (cephalic, gastric, intestinal) and their stimulant pathways
- Chyme production and its effects upon the pyloric sphincter
- Factors affecting gastric emptying (duodenal luminal pH, fats, distension)

Small intestine

- Duodenally-mediated inhibition of gastric juice release and its hormonal components
- Effects of addition of water, bicarbonate and bile upon duodenal chyme
- Functional anatomy of the intestinal villus
- Importance of the sodium pump in creating the osmotic gradient of the small intestine
- Carbohydrate handling (brush border enzymes, cotransporters, diffusion)
- Functional effects of proteases and carboxypeptidase
- Calcium absorption via Ca-ATPase and Na-Ca antiporter mechanisms
- Iron absorption via ascorbate complexes and carrier proteins
- Fat handling (emulsification agents, micelles) and the handling of fat-soluble vitamins

Pancreas

- Principal constituents of the exocrine pancreatic juice
- Function and origin of CCK
- Function and origin of secretin

Liver

- Constituents of a portal triad
- Origin and constituents of hepatic bile
- Pathway of enterohepatic circulation

Gallbladder

- Appreciation of both its storage and metabolic roles (bile concentration region)
- Stimulants to bile formation (bile salts, secretin, glucagons, gastrin)
- Role of CCK and vagal stimulation in bile release

Large intestine

- Factors affecting opening of the ileocaecal sphincter
- Functional role of the taeniae coli via autonomic innervation
- Handling of chyme as being a combination of mixing + propulsion
- Role of Na-K-ATPase in water absorption against a concentration gradient
- Overview of the role of colonic bacteria (vitamin synthesis, bile + bilirubin handling)
- Functional basis of colonic mass movement (based upon mid-zone GI distension)
- Basis of the defecation reflex

Section 5 Renal physiology

Functional anatomy of the renal tract

Note: you should cross-reference this section with the anatomy curriculum

Macroscopic structure of the kidney:

- Cortex + medulla and the principal components of each (e.g. location of glomeruli)
- Composition of the nephron (Bowman's capsule, tubules etc)
- Function (in broad terms) of each component of the nephron
- Appreciation of how nephron anatomy reflects these functions

Renal blood supply and drainage

- Appreciation of the rich vascularity of the kidney and the rationale for this
- Structural arrangement of afferent and efferent arterioles
- Importance of renal autoregulation and a simple overview of factors affecting it

Mechanism of filtration in health

Glomerular filtration

- Normal GFR and filtration fraction in adults
- The three glomerular filtration barriers and the importance of molecular size
- Factors affecting GFR (Starling forces, relative arteriolar resistance)
- The role of vasoactive substances in affecting GFR

Creatinine clearance

- Understanding of why creatinine is chosen for the clearance calculation
- Knowledge of the equation $(C_u \times V) / C_p$ in calculating clearance
- Knowledge of inulin and PAH as function indices is NOT required

Tubular transport

- Available modes of tubular transport (paracellular and transcellular)
- Simple understanding of the difference between primary + secondary active transport
- Concept of maximal tubular transport and implications for glucose threshold
- Plasma level of glucose above which spillover and saturation occur

Proximal tubular function

- Appreciation of the principal agents reabsorbed at this site
- Understanding of the particular dynamics of sodium and glucose in this region

Loop of Henle

- Primary functions of the thin and thick limbs
- Importance of the counter-current multiplier
- Effect of loop diuretics upon thick limb symporters

Distal collecting system

- Water permeability of this region and the effect of ADH upon water + urea handling
- Role of urea in maintenance of medullary osmolality
- Relation of potassium excretion to tubular flow and the implication for diuretic therapy

- Roles of PTH and activated Vitamin D in the handling of calcium in this region

Regulation of plasma osmolality

- Overview of regulatory mechanism (hypothalamus, ADH, thirst, feedback loop)
- Effects of ADH upon vascular tone systemically and renally
- Sites of metabolism of ADH and appreciation of its rapid removal via feedback

Effects of renal hormones

- Angiotensin II as the principal agent in sodium balance
- Role of ACE in generating angiotensin II
- Effects of angiotensin II on vessels, tubules, hypothalamus, adrenal cortex
- Positive and negative feedback effects of angiotensin II
- Effects of aldosterone and ANP in health

Acid – base balance

Normal values

- Normal range of arterial blood pH and the importance of maintenance of this range
- Henderson-Hasselbach equation for bicarbonate and CO₂ equilibrium
- The anion gap – components and calculation

Metabolic disturbance

- The typical ABG features of metabolic + respiratory alkalosis and acidosis
- An understanding of the primary systemic compensations which occur in each type

Renal regulation of acid – base balance

- Urinary acidification (bicarbonate reabsorption + acid formation + handling of ammonia)
- The kidneys as net renal excretors of acid
- Factors influencing renal secretion and excretion of hydrogen ions

Potassium balance

Normal values

- Intracellular and extracellular normal potassium concentrations

Effect of disordered potassium balance

- The main clinical effects of hypo- and hyper- kalemia, including ECG effects

The handling of potassium through the renal tract

- Influence of aldosterone, acid – base disturbance, sodium excretion

Calcium balance *(see also Section 6 below)*

Normal values

- Normal values of calcium and the rationale for corrected calcium values

Sources and handling of calcium

- Foodstuffs rich in calcium
- Sites of calcium transfer along the nephron in health
- Effect of PTH upon renal calcium handling

Section 6 Endocrine physiology

Note

In this section, the emphasis is on those aspects of endocrine function most relevant to emergency medicine. The principle of feedback loops has already been mentioned. You can assume that endocrine systems NOT mentioned are NOT required knowledge.

Pituitary function

Functional anatomy

- Anatomical location of the pituitary and its location on skull x-rays and cerebral CT scans
- Its subdivision into adeno- and neuro- hypophyses and their broad functions
- A simple understanding of the close relationship between hypothalamus and pituitary
- Appreciation of the roles of hypothalamic releasing hormones CRH, TRH, dopamine
- Anterior pituitary as the source of ACTH & TSH
- Posterior pituitary as the source of ADH

Effect of disordered function

- The clinical implications of disordered secretion of the hormones listed above
- Physiological basis of diabetes insipidus and SIADH

Adrenal function

Functional anatomy

- Location of the glands and their subdivision into medulla and cortex

Cortical function

- Cortex as the source of mineralo- and gluco- corticoids
- Regulation of adrenal cortical function in health
- Relation of cortisol secretion to stress and the role of this response

Effects of glucocorticoids

- Metabolic and pharmacological properties (overview only; cellular detail *not* required)

Clinical effects of disordered glucocorticoid secretion

- Physiological basis of Cushing's syndrome and adrenal insufficiency

Medullary function

- Adrenal medulla as a key component of the sympathetic nervous system
- Overview of adrenaline / noradrenaline degradation pathways

Adrenaline

- Its metabolic, cardiovascular and pulmonary effects

Clinical effects of disordered medullary function

- Physiological basis of pheochromocytoma and its clinical effects

Endocrine pancreas

- Normal value of blood glucose

Functional anatomy of the endocrine pancreas

- Beta cells as insulin production units; alpha cells as glucagons production units

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Insulin physiology

- Stimulants to production
- Proinsulin and C-peptide as necessary precursors in insulin manufacture
- The insulin receptor and intracellular signalling paths as vital links in the effector chain
- Effects of insulin upon glycogen, glycolysis, lipolysis and protein synthesis

Glucagon physiology

- Stimulants to production
- Effects of glucagon upon hepatic handling of glycogen, glucose, urea, fat and ketones

Diabetes mellitus

- Physiological basis of insulin- and non-insulin- dependent diabetes mellitus
- Clinical effects of untreated diabetes

Thyroid physiology

Functional anatomy

- Gross anatomical location (*cross-reference to anatomy curriculum*)
- Thyroid as the site of production of T3 and T4 (details of cellular manufacture *not needed*)

Transport of thyroid hormones

- Normal values of TSH and T4 hormone in health
- Importance of binding proteins in transport and concept of 'free' hormone
- Appreciation of the peripheral metabolism of T4 to T3

Physiological effects

- Cardiac output, and calorific effect, as type examples

Effects of disordered function

- Physiological basis of hypo- and hyper- thyroidism

Calcium and bone physiology (*see also end of Section 5 above*)

Functions of calcium in health

- Physiological actions of calcium
- Transportation of calcium (ionised, complexed, bound)

Factors affecting calcium handling

- PTH, calcitonin and vitamin D3 and their effects on kidney, bone + small intestine

Effects of disordered calcium physiology

- Physiological basis of osteoporosis and osteomalacia
- Clinical effects of reduced bone density in the context of trauma

3. Summary of the pharmacology curricular content

Gastrointestinal pharmacology (BNF SECTION 1)

Dyspepsia & GORD	1.1
You should be familiar with the principle that drug management is based upon symptom severity and often requires patient lifestyle changes in order to achieve maximal success.	
Antacids	1.1.1
The following as typical type substances <ul style="list-style-type: none"> Aluminium hydroxide (tending to be constipative) Magnesium carbonate (tending to be laxative) Appreciation of the potential for reduced absorption of other important drugs.	
Antispasmodics	1.2
Antimuscarinics <ul style="list-style-type: none"> their cautions contra-indications and side-effects Specific knowledge is not required but you should be aware of the limited clinical utility of hyoscine butylbromide based upon its poor absorption.	
Ulcer-healing drugs	1.3
<i>The introductory section of the BNF gives a useful overview of management issues in ulcer disease but you are not expected to know the recommended therapy regimens.</i> The section entitled NSAID-associated ulcers is however required knowledge.	
Specific knowledge: Proton-pump inhibitors <ul style="list-style-type: none"> Mechanism of action Their role in NSAID-associated ulcers Cautions, side-effects Omeprazole as a type substance: dosages (PO & IV)	1.3.5

Acute diarrhoea	1.4
<p>Awareness of the need to focus management upon fluid & electrolyte losses</p> <p>The limitations of antimotility drugs, especially in children</p> <p>The lack of role for antispasmodics in emergency management and in children</p> <p>Specific drug knowledge is NOT required</p>	
Chronic bowel disorders	1.5
<p>Patients who present with acute exacerbations of a known inflammatory bowel disease often require specialist advice and input</p> <p>Treatment of acute exacerbations:</p> <ul style="list-style-type: none"> • Principles of management • Local steroids and aminosalicylates • Oral aminosalicylates • Oral steroids <p>Specific knowledge of drug types (eg mesalazine) is NOT required.</p>	
Laxatives	1.6
<p>The principles of laxative prescribing outlined in the relevant section of the <i>BNF</i> should be understood in order to appreciate the very limited role for their use in the Emergency Department, especially in children.</p> <p>Likewise the risks of prescribing stimulant laxatives (eg sodium picosulphate) should be understood.</p> <p>Specific drug knowledge is NOT required.</p>	

Cardiovascular system

(BNF SECTION 2)

Important note

The knowledge requirements for this section of the pharmacology curriculum reflect the importance of cardiovascular disease in many Emergency Department presentations. Your learning will be facilitated by knowledge of the key management steps in these presentations, in particular the following:

- Acute coronary syndrome
- Tachy- and brady-arrhythmias
- Acute cardiac failure

You will find it helpful to refer to clinical textbooks as you learn the basic pharmacology content detailed below. In addition, you should cross-reference your learning with that of the physiological principles which underlie the actions of the agents in this section.

Although the specific knowledge requirements are listed, the context of their use in clinical practice demands wider reading.

Cardiac glycosides	2.1.1
Specific knowledge: <ul style="list-style-type: none"> • Digoxin • Digoxin-specific antibody 	
Diuretics	2.2
You should be aware of the broad categorisation of diuretics (loop, potassium-sparing, osmotic etc) and the risks of hypokalaemia associated with thiazides and loop compounds.	
Thiazides	2.2.1
Specific knowledge: <ul style="list-style-type: none"> • Bendroflumethiazide 	
Loop diuretics	2.2.2
You should be aware of the pharmacological principles underlying their mechanism of action. Specific knowledge of the following 2 drugs encompasses the required level of detail. Specific knowledge: <ul style="list-style-type: none"> • Furosemide • Bumetanide 	
Osmotic diuretics	2.2.5
Specific knowledge: <ul style="list-style-type: none"> • Mannitol NB in relation to its role in acute cerebral oedema	
Anti-arrhythmics	2.3.1
A sound grasp of the specific knowledge demands an equally sound grasp of the emergency management of the conditions they are used in. You should revise the relevant algorithms as part of your learning. Knowledge of the Vaughan Williams classification is NOT required. The relevant introductory sections of the BNF should be known in addition to the detail in relation to specific drugs listed.	

Specific knowledge: <ul style="list-style-type: none"> • Adenosine • Amiodarone • Flecainide • Lidocaine 	
Beta-adrenoceptor blockers	2.4
<i>The BNF has a useful introductory section on this topic.</i> Specific knowledge: <ul style="list-style-type: none"> • Propranolol • Esmolol • Labetalol • Sotalol 	
Hypertension & heart failure	2.5
You should be aware of the thresholds and treatment targets for hypertension, in particular the indications for emergency management. The BNF has a useful section in relation to this and other broad therapy issues, which should be understood, in particular the measures of use to reduce cardiac risk and the implications of hypertension in other disease states and in pregnancy.	
Vasodilators	2.5.1
Specific knowledge: <ul style="list-style-type: none"> • Sodium nitroprusside 	
Alpha-blockers	2.5.4
Knowledge of the principles of management of hypertensive crises in phaeochromocytoma: specific drug knowledge not required	
Renin-angiotensin system drugs	2.5.5
You should be aware of the management principles of chronic heart failure as outlined in the introductory section of the BNF, although detailed knowledge is not required	

ACE inhibitors	
<p>You should be aware of their indications, renal effects, cautions and contra-indications. Many patients are prescribed ACE inhibitors within primary care, and a working knowledge of the pharmacology may be a key element of emergency care.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Captopril as a type substance within this classification 	
Nitrates and anti-anginal drugs	2.6
<p>Pharmacological management of anginal symptoms is summarised in the introductory section of the <i>BNF</i> but you should ensure that you have a broader clinical knowledge in learning these drugs and their uses.</p>	
Nitrates	2.6.1
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Glycerol trinitrate 	
Calcium-channel blockers	2.6.2
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Verapamil • Nifedipine • Nimodipine 	
Sympathomimetics	2.7
<p>Inotropic</p> <p>Their role -and limitations- in shock</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Dobutamine • Dopamine <p>Vasoconstrictor</p> <p>Their mechanism of action and very limited role in the emergency setting</p> <p>Specific drug details beyond names (ephedrine, metaraminol) are not required</p>	

Drugs used in resuscitation	2.7.3
<p>You should be fully conversant with the most recent Advanced Life Support algorithms and have specific knowledge of the key drugs</p> <ul style="list-style-type: none"> • Adrenaline • Amiodarone • Atropine 	
Anticoagulants	2.8
Principles of management of thromboembolic disease	
Parenteral preparations	2.8.1
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Heparin • Enoxaparin as a low molecular weight heparin type substance • Practical differences between unfractionated and LMW heparins • Protamine sulphate 	
Oral preparations	2.8.2
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Warfarin 	
Antiplatelet drugs	2.9
<p><i>The introductory section of the BNF provides a useful overview.</i></p> <p>You should be aware of the NICE recommendations for the use of GIIb/IIIa inhibitors in the management of NSTEMI</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Abciximab as a type GIIb/IIIa inhibitor substance • Aspirin • Clopidogrel 	

Myocardial infarction & fibrinolysis	2.10
<p>You must be fully conversant with the clinical management pathways for acute myocardial infarction</p> <ul style="list-style-type: none"> • Fibrinolytics • Specific knowledge • Streptokinase • Tenecteplase • Reteplase 	
Lipid-regulating drugs	2.12
<p>Many patients are prescribed these medications so a working knowledge of their pharmacology is essential</p> <p><i>You should be aware of their pharmacological context as outlined in the relevant introductory section of the BNF</i></p>	
Statins	
<p>You should be aware of their indications, cautions, contra-indications (specifically liver disease, pregnancy and lactation) and side -effects</p> <p>Specific drug knowledge beyond names is NOT required</p>	

Respiratory system

(BNF SECTION 3)

Bronchodilators	3.1
<p><i>You should be familiar with the introductory text "Asthma" in the BNF for this section, but not the tables "Management of chronic asthma in adults and children" or "Management of acute severe asthma in general practice". The curriculum assumes you know the BTS/ SIGN Guidelines in relation to emergency clinical management.</i></p>	
Selective beta-2 agonists	3.1.1
<p><i>The introductory text for this section in the BNF gives a useful overview.</i></p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Salbutamol <p>Dosages and details for terbutaline, salmeterol and others in this section are NOT required</p>	

Antimuscarinics	3.1.2
Specific knowledge: <ul style="list-style-type: none"> • Ipratropium 	
Theophylline	3.1.3
<i>Introductory BNF text should be known.</i> Specific knowledge: <ul style="list-style-type: none"> • Aminophylline 	
Corticosteroids	3.2
<i>The introductory text in the BNF provides key information.</i> Specific knowledge: drugs to be known as type examples <ul style="list-style-type: none"> • Hydrocortisone • Beclomethasone 	
Antihistamines	3.4
<i>You should learn the detail of the introductory text from the BNF for this section.</i> Specific knowledge: <ul style="list-style-type: none"> • Cetirizine (type example of a non-sedating drug) • Chlorpheniramine (type example of a more sedating drug) • The physiological basis for differences in sedative function should be known 	
Allergic emergencies	3.4.3
<i>Full knowledge of the introductory section of the BNF is expected</i> Specific knowledge: <ul style="list-style-type: none"> • Adrenaline 	
Oxygen	3.6
<i>Introductory text within BNF</i> Knowledge of the basics of intermittent and longer-term oxygen therapy to the level of detail contained within the BNF is useful in the assessment of ED patients with oxygen-dependent disease Detail in relation to oxygen supply arrangements is NOT required	

**Central nervous system
(BNF SECTION 4)**

Hypnotics & anxiolytics	4.1
<p>You should be familiar with the introductory text in the BNF for this section, especially an appreciation of the implications of benzodiazepine withdrawal and the limitations on their utility in chronic anxiety states.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Diazepam • Chlordiazepoxide • Lorazepam 	
Antipsychotics	4.2.1
<p>The introductory text for this section in the BNF gives a useful overview.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • The nature and pharmacological basis of extrapyramidal symptoms • Dosages and details of specific drugs are NOT required 	
Antimanic drugs	4.2.3
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Lithium <ul style="list-style-type: none"> ○ Importance of serum concentration ○ Clinical features of overdose ○ Importance of 'lithium cards' 	
Tricyclic antidepressants	4.3.1
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Amitryptiline - not in the context of enuresis 	
Drugs used in nausea & vertigo	4.6
<p>The introductory text in the BNF provides key information.</p> <p>Specific knowledge: drugs to be known as type examples</p> <ul style="list-style-type: none"> • Antihistamines • Cyclizine • Phenothiazines 	

<ul style="list-style-type: none"> • Prochlorperazine • Metoclopramide 	
Analgesics	4.7
<i>You should learn the detail of the introductory text from the BNF for this section.</i>	
Nonopioid analgesia	4.7.1
<p><i>See also musculoskeletal pharmacology</i></p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Aspirin • Paracetamol 	
Opioid analgesia	4.7.2
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Morphine salts • Codeine phosphate • Tramadol 	
Antiepileptics	4.8
<p><i>Introductory text within BNF</i></p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Carbamazepine • Phenytoin • Valproate 	
Status epilepticus	4.8.2
<p><i>Introductory text within BNF</i></p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Lorazepam, diazepam & midazolam • Phenytoin • Paraldehyde 	

Infections

(BNF SECTION 5)

Important note

Throughout this section, it is important that you understand the microbiological principles upon which infections are treated. To facilitate learning it will be necessary to cross-reference the required knowledge to a microbiology textbook in addition to your pharmacology resources.

Where specific drugs are listed then you should take care to ensure you are familiar with them. They may also be listed as "type examples" – this refers to the fact that, alongside a detailed knowledge of that drug, you should be aware of the fact that it describes the actions of a wider drug family in some important way.

Note regarding notifiable diseases

You are expected to be aware of those conditions requiring notification to the authorities.

These are listed in the most current edition of the BNF.

Antibacterial drugs	5.1
<i>There is a useful introductory text in the BNF. You should familiarise yourself with its content.</i> <i>Tables 1 (Summary of antibacterial therapy) and 2 (Summary of antibacterial prophylaxis) are required knowledge and you will be expected to be aware of the recommended first-line therapeutic agents for the conditions listed.</i>	
Penicillins	5.1.1
The mechanism of action of penicillins at the cellular level; Implications of allergy or atopy in the prescribing of penicillins. Specific knowledge: <ul style="list-style-type: none">• Benzylpenicillin• Phenoxymethylpenicillin• Flucloxacillin: the basis for its utilisation in terms of penicillinases; implications of MRSA• Amoxicillin• Ampicillin• The specific indications for use of co-amoxiclav	

Cephalosporins	5.1.2
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Cefalexin • Cefotaxime • Ceftriaxone • Cefuroxime <p>Knowledge in relation to drugs not listed (eg aztreonam, meropenem) is NOT required.</p>	
Tetracyclines	5.1.3
<p>These drugs continue to be of value in the management of chlamydia and Lyme disease amongst others, and for that reason they constitute required knowledge. The introductory section of the <i>BNF</i> is useful as an overview but you will need to supplement your learning from textbooks for more detail in relation to the specific knowledge drug.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Doxycycline - as a type example 	
Aminoglycosides	5.1.4
<p>You should be aware of the importance of monitoring serum concentrations for these agents, and understand this in terms of their pharmacodynamics.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Gentamicin - as a type example 	
Macrolides	5.1.5
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Erythromycin 	
Other antibiotic agents	5.1.7
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Chloramphenicol eye preparations • Fusidic acid • Vancomycin • Metronidazole 	

Management of tuberculosis	5.1.9
<p>You must be familiar with the principles of management of TB not just the pharmacological aspects listed below.</p> <p>Specifically you should be familiar with:</p> <ul style="list-style-type: none"> • The "initial phase" management involving 4 drugs, including their names • The implications of pregnancy and breastfeeding • The importance of hepatic and renal function checks • Details of individual drugs in terms of dosages, side-effects etc is NOT required 	
Quinolones	5.1.12
<p>You should be aware of the CSM advice in relation to the risks of tendon damage in patients prescribed a quinolone.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Ciprofloxacin - as a type example <p>Dosage knowledge is required in relation to UTI and gonorrhoea</p>	
Urinary tract infections	5.1.13
<p>You must be familiar with the common microbial agents implicated in UTI and the importance of early antibacterial treatment of childhood infections.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Trimethoprim 	
Antifungal preparations	5.2
<p>Knowledge requirements are limited to an understanding of management of candidiasis.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Nystatin 	
Herpesvirus infections	5.3.2
<p>Herpes simplex & varicella-zoster</p> <p>You must understand the pharmacological management of simplex and varicella infections, in particular with reference to:</p> <ul style="list-style-type: none"> • HSV-1 and HSV-2 and their usual sites of infection; • Treatment principles of localised ocular or lip infection; 	

<ul style="list-style-type: none"> • Indications for systemic antiviral therapy for simplex infection; • Management implications of neonatal chickenpox; • Problems of exposure to varicella during pregnancy; • Management of shingles. <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Acyclovir 	
Antimalarials	5.4.1
<p>It is important that you understand the pharmaceutical approach to management of falciparum malaria.</p> <p>This is because it represents the initial management approach where the causative organism is unknown, as will be the case in ED presentations of fever in a returning traveller in whom the diagnosis is suspected.</p> <p>Although the specific dosages of the first-line agents are not required knowledge, you should be familiar with:</p> <ul style="list-style-type: none"> • The use of quinine or Malarone as the initial agent • The implications for management in pregnant patients <p>You should understand the implications of patients who return from malarial regions with illness in the year following travel.</p> <p>Chemoprophylaxis and specific recommendations: specific knowledge is NOT required.</p>	

Endocrine system

(BNF SECTION 6)

Diabetes	6.1
<p>Apart from the pharmacological knowledge detailed below, you must be familiar with the clinical management of diabetic emergencies and the spectrum of initial presentations.</p>	

Insulin	6.1.1
<p>You should be aware of the pharmacological basis of insulin's use in diabetes. <i>The BNF provides an overview, which must be supplemented by textbook reading.</i></p> <p>An understanding of the treatment principles of diabetes, including the 3 main types of insulin preparations, the usual approaches to treatment regimens, and the methods of administration, is essential.</p> <p>You should know the implications of diabetes for driving a motor vehicle.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Use of insulin in management of diabetic ketoacidosis 	
Oral antidiabetic drugs	6.1.2
<p>You should be familiar with the <i>principles</i> of drug management using oral hypoglycaemic agents (eg sulphonylureas) and anti-hyperglycaemic agents (eg biguanides) but specific knowledge of the individual drugs is <i>not</i> required.</p>	
Treatment of hypoglycaemia	6.1.4
<p>A sound knowledge of the clinical management of hypoglycaemia is expected as part of your wider clinical learning.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Glucagon 	
Thyroid disease	6.2
<p>Thyroid hormones and antithyroid drugs</p> <p>You should be aware of the principles of management of hypothyroidism and thyrotoxic crisis</p> <p>Specific knowledge of hormones and antithyroid drugs is NOT required</p>	
Corticosteroids	6.3
<p>You should be familiar with the physiological basis of adreno- and cortico-steroids</p>	

Glucocorticoids	6.3.2
<p>Familiarity with the range of commonly-prescribed glucocorticoids (hydrocortisone, prednisolone and dexamethasone) is expected to the level outlined in the <i>BNF</i>.</p> <p>In particular you should understand the differences in mineralo- and gluco-corticoid effects of these agents, in order to appreciate why a given drug is chosen in a given situation.</p> <p>You should understand the implications of therapy in terms of:</p> <ul style="list-style-type: none"> • Adrenal suppression • Infections • Chickenpox • Measles <p>You also need to be aware of the use of "steroid cards" and the implications of sudden withdrawal.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Prednisolone • Hydrocortisone • Other endocrine drugs and agents <p>Knowledge of other drugs not listed above is NOT required.</p>	

**Fluids and electrolytes
(BNF SECTION 9)**

Oral preparations	9.2.1
<p>You should be aware of the pharmacological basis of situations in which patients may be required to take long-term oral potassium supplements (eg digoxin use, nephrotic syndrome) since these patients may present to the ED.</p> <p>Specific knowledge of oral potassium dosages is not required</p> <p>Oral rehydration therapy</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • "Dioralyte" - as a type example 	

Parenteral preparations	9.2.2
<p>You should be familiar with the basis of the need for intravenous replacement therapy.</p> <p>You should be familiar with the relative constituent compositions of the commonly-used mixtures</p> <ul style="list-style-type: none"> • Sodium chloride • Hartmann's • Specific knowledge: • Sodium chloride • Glucose • Potassium chloride mixtures • Sodium bicarbonate • Albumin • Gelatin 	
Vitamin B	9.6.2
<p>You should be familiar with the management principles of B vitamin deficiency particularly in relation to Wernicke's and Korsakoff's states.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Thiamine - including CSM advice. 	

Musculoskeletal system

(BNF SECTION 10)

Note

Analgesic drugs are covered in the section entitled "Central Nervous System".

Nonsteroidal anti-inflammatory drugs	10.1.1
<p>You should be aware of the wider clinical management of those conditions which often attract NSAID therapy in the Emergency Department – for example, the use of immobilisation, physiotherapy and lifestyle adjustments.</p> <p>The knowledge requirements for this section are constructed to allow an understanding of the different properties of key NSAIDs hence an ability to target choice to presenting condition.</p> <p>You should be aware of the need to balance efficacy against side-effects.</p> <p>The pharmacological basis of gastro-intestinal intolerance (including cox-2) should be understood.</p> <p><i>The introductory section in the BNF provides a useful overview which should be supplemented by the recommended textbook.</i></p> <p>Specific knowledge:</p> <ul style="list-style-type: none">• Ibuprofen• Naproxen• Diclofenac• Mefenamic acid (noting its haematological side-effects) <p><i>Aspirin appears elsewhere in the curriculum.</i></p>	
Corticosteroids	10.1.2
<p><i>These drugs also appear in the curriculum section "Endocrine System"</i></p> <p>Systemic</p> <ul style="list-style-type: none">• You should understand the pharmacological basis of using corticosteroids in inflammatory disease, including RA and temporal arteritis• Specific knowledge of dosage regimens for rheumatic diseases is NOT required <p>Local</p> <ul style="list-style-type: none">• <i>The relevant section of the BNF contains a summary which should be understood</i>• Specific dosage knowledge is NOT required	

Drugs used in gout & hyperuricaemia	10.1.4
<p>The clinical management of suspected gout in the acute phase should be known</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Colchicine (particularly in patients with heart failure or taking anticoagulants) 	

Immunological products and vaccines

(BNF SECTION 14)

Note

Although the range of immunological products used in Emergency Departments is relatively small, it is important to be fully aware of the principles which underpin their effectiveness. The curriculum detail reflects this.

Active Immunity	14.1
<p>The types of vaccine (live attenuated, inactivated and detoxified exotoxin) with examples of each; key differences between the types</p> <p>Side-effects and contra-indications</p> <p>An awareness of the management and parental advice required in post-immunisation infant pyrexia</p> <p>Required knowledge:</p> <ul style="list-style-type: none"> • The United Kingdom immunisation schedule. 	
Passive Immunity	14.2
<p><i>See Immunoglobulin section below</i></p> <p>Awareness of the pharmacological basis of passive immunity and the reasons for the use of immunoglobulins wherever possible.</p>	
Specific vaccines and preparations	14.4
<p>Specific knowledge (to the level of detail outlined in the <i>BNF</i>):</p> <ul style="list-style-type: none"> • BCG • Diphtheria (see also required knowledge for UK immunisation schedule) • Haemophilus influenzae type B (Hib) • Hepatitis A 	

<ul style="list-style-type: none"> • Hepatitis B • Measles, mumps & rubella (MMR) • Meningococcal vaccines • Pertussis and Poliomyositis (<i>see also required knowledge for UK immunisation</i>) • Awareness of the post-exposure management of rabies is required • Tetanus vaccines: management of wounds in respect of tetanus risk 	
Immunoglobulins	14.5
<p>Types of immunoglobulin: normal and specific</p> <p>Normal Ig</p> <ul style="list-style-type: none"> • Its uses, cautions & side effects in relation to protection of susceptible patients from hepatitis A and measles; <p>Specific Ig</p> <ul style="list-style-type: none"> • Hepatitis B (HBIG), tetanus and varicella-zoster Ig as type examples; • The indications for administration of these three vaccines. <p>Anti-D Ig</p> <ul style="list-style-type: none"> • Immunological basis and indications for administration. 	

Anaesthesia

(BNF SECTION 15)

Note

It is well recognised that the administration of anaesthetic agents should **only** be performed by clinicians who are **fully competent in advanced airway management**.

Knowledge requirements in this section relate to those anaesthetic drugs used in the Emergency Department for the purposes of sedation, control of fitting and rapid-sequence induction.

Your learning should encompass the tissue and metabolic effects, and pharmacodynamics, of the drug examples listed.

Intravenous agents	15.1.1
<p>You should be aware of the nuances of:</p> <ul style="list-style-type: none"> • Thiopental sodium • Etomidate 	

<ul style="list-style-type: none"> • Propofol • Ketamine <p>In relation to their induction profile, common side-effects and contra-indications</p> <p>Specific dosage knowledge is NOT required</p>	
Inhalational agents	15.1.2
<p>Specific knowledge:</p> <ul style="list-style-type: none"> • Nitrous oxide 	
Sedatives and analgesics	15.1.4
<p>Benzodiazepines</p> <p>You should be aware of the nuances of:</p> <ul style="list-style-type: none"> • Diazepam • Temazepam • Lorazepam • Midazolam • In relation to their duration of action, sedative and amnesic effects and common side-effects. • Specific knowledge: <ul style="list-style-type: none"> • Diazepam • Lorazepam 	
Muscle relaxants	15.1.5
<p>You should understand the pharmacological basis of depolarising and non-depolarising agents.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Atracurium • Suxamethonium 	
Antagonist agents	15.1.7
<p>You should understand the pharmacological basis of flumazenil and its contra-indications.</p> <p>Specific knowledge:</p> <ul style="list-style-type: none"> • Naloxone 	
Local anaesthesia	15.2
The introductory section of the <i>BNF</i> provides a useful overview of	

these agents which must be supplemented by textbook reading.

Specific knowledge:

- Lidocaine
- EMLA
- Bupivacaine
- Prilocaine

4. Summary of the microbiology curricular content

Introduction

This document contains the core content for the MCEM Examination in relation to applied microbiology. Questions will be set based upon the listed topics that follow. Where appropriate, comments are included to guide you in relation to the depth of knowledge required.

Whilst learning the core content, remember that the purpose of learning microbiology rests upon its implications for safe clinical practice. The clinical effects of infection reflect underlying pathological processes that are important to know.

The content of the document has been derived through systematic analysis of expert group opinion. This methodology represents one of the best established ways of determining relevant knowledge.

Format

The document is arranged logically based upon broad topics to allow for easy study. There is naturally some overlap between topics and this means that some facts may be mentioned more than once.

Learning the content

This document tells you what you need to know but does not tell you how to learn it. Individual learning styles vary from rote-remembering of lists to patient-based learning. What matters is that you find a learning style which suits your abilities and aptitude: if you are finding this difficult, seek advice from your educational supervisor.

Review and corrections

This curriculum is subject to periodic review to ensure that it meets its educational objectives. If you have any comments to make in relation to the accuracy or terminology of its content then please contact us at the College and we will be happy to hear from you.

Part A: Principles of microbiology

Section 1: Natural and innate immunity

This section outlines some important principles of the normal innate immune system and identifies key knowledge items.

Barriers to infection

- Skin as both a physical and chemical (sebum, inhibitory fatty acids) barrier
- Recognition of the potential risk of breach of skin integrity (HIV, hep B)
- Recognition of the enhanced infection risk from burns, eczema, psoriasis

- Mucociliary - the role of the clearance mechanism in producing an effectively sterile lower respiratory tract
- Secreted antibacterial compounds – lysozyme (tears) as an example
- Gastric acid
- Urinary - effective sterility of the urinary tract due to flushing action

Normal bacterial flora

- The protective role of normal flora via competition for pathogen colonisation sites
- Appreciation of the role of secreted bacteriocins in organism suppression
- Risks of antibiotics in terms of flora suppression (see *C. difficile* later)

Phagocytes and complement

- Role of neutrophils and macrophages in pathogen ingestion
- Role of opsonins in enhancing this activity (a simple appreciation only)
- Effects of splenectomy on normal macrophage function
- Complement as a protein system that generates a 'membrane attack complex'
- Effects of complement deficiency: susceptibility to *N. meningitidis*, *S. pneumoniae*
- A detailed knowledge of the complement cascade is NOT required

Section 2: Mechanisms of disease

You should be aware of basic terminology:

- Colonisation is a normal state and is not pathological
- Pathogen is an organism capable of causing an infection
- Infection describes a microbe-induced state of disease

You should be aware of the broad difference between obligate (eg HIV), conditional (eg *S aureus*) and opportunistic (eg *Pneumocystis sp*) pathogens.

Mechanisms of attachment, invasion and persistence

Appreciation of the variety of attachment strategies used by microbes, with the following as clinically relevant type examples:

- Influenza virus: Attaching via a haemagglutinin antigen
- *Giardia lamblia*: Attaching to gut mucosa via a specialised sucking disc
- *P falciparum*: Causing red cell protein expression facilitating cerebral malaria
- *HIV*: Binding strongly to CD4 antigen

The ability of microbes to survive and flourish once beyond natural barriers:

- *N meningitides*: As an IgA protease producer (leading to barrier breakdown)
- *S aureus*: As an expressor of protein A which inhibits complement activation
- *S pneumoniae*: As having a specialised capsule which inhibits neutrophil action
- *V cholerae*: As a flagellated motile microbe, enhancing its virulence

The ability of some microbes to generate damaging toxins:

- *Cholera toxin*: Its ability to stimulate diarrhoea via epithelial irritation in the gut

Tetanus toxin: Its ability to disrupt neurological signalling and integrity

A detailed knowledge of endo- and exo-toxin producing microbes is NOT required.

Section 3: Controlling infection

This important section outlines key knowledge in relation to simple infection control.

Endogenous and exogenous infection sources

Endogenous infection: Invasion under particular conditions by normal flora

Type conditions:

- Aspiration pneumonia
- neutropenic sepsis
- cannulation

Exogenous infection: Organisms acquired from a non-host origin

Type examples:

- Legionella
- Clostridium
- Salmonella

In each of these type examples there are particular environmental circumstances which make infection highly likely and you should have an appreciation of what these circumstances might be.

How infection spreads

You should have an appreciation of how microbes commonly spread in broad terms:

- Droplet spread Influenza; N meningitidis
- Faecal; oral Salmonella
- Invasion of intact skin; Leptospira
- Invasion of breached skin; S epidermidis
- Sexual intercourse HIV; N gonorrhoeae

Hospital-acquired infection

Defined as an infection which was not present or incubating at the time of hospital admission.

- Predispositions: Air conditioning and piped air supplies (eg *Legionella*)
- Fomites (eg contaminated vases, fans, viewing boxes)
- Hospital food (temperature, issues of transport to ward)
- Water supplies (eg *Legionella* in lukewarm pipework)
- Patient-centred factors: Restricted ability to access washing facilities
- Effects of disease or treatment in lowering resistance
- Effects of close patient contact in a busy ED
- Cannulation: Commonest cause of hospital bacteraemia
 - Infection risk as a direct effect of length of time in situ
 - Need to replace peripheral cannulas at 48h
 - Type organisms: *S aureus*, *S epidermidis*
- Urinary catheters: Effects of urinary stasis and colonisation
- Staff clothing: Importance of the 'bare below the elbows' approach

Control of hospital-acquired infection

- Good clinical practice: The correct method for hand-washing should be known
- Isolation of patients: Importance of aprons, gloves, sink and alcohol gel
- Disinfection: As a reduction in the number of infectious particles
- Disinfectants: As substances which *kill or inhibit* microbes
- Iodine: As a slow-acting skin anti-bacterial disinfectant
- Chlorhexidine: As an anti-staphylococcal agent
- Sterilisation: As the inactivation of all infectious agents
- Autoclaving and irradiation: As the main methods used

Section 4: Principles of investigation

This section is included to ensure that you have a basic appreciation of the methods used by the laboratory to investigate infections relevant to the Emergency Department.

Specimen types

The following as type examples of specimens required:

Urinary tract infection	Skin wounds	Meningitis	Nonspecific pyrexia	Pneumonia
MSSU	Wound swab	CSF + blood	Blood: culture + serology	Blood + sputum

Specimen culture

- Its role in amplification of organism quantity to allow reliable detection.
- Appreciation that there are *liquid medium* and *solid medium* types of culture.

Specimen examination

The following as type examples of how specimens are examined:

Light microscopy				Fluorescent microscopy
Direct	Gram stain	Z-N stain	Giemsa stain	
Stool parasites	CSF bacteria	Sputum TB	Blood malaria	Sputum RSV

Serology

- As a process where pathogens are identified via the immune response they raise
- Awareness that diagnosis usually rests upon rising or falling levels of antibodies in serial specimens
- Specific antigen detection as an alternative method, with CSF bacterial capsular antigens as a type example

Molecular techniques

- Nucleic acid amplification as a technique used for diagnosis where the microbe is slow growing (eg *M. tuberculosis*, *C trachomatis*)

Section 5: Principles of immunisation

Normal childhood immunisation schedule

You should know the usual UK immunisation schedules for the vaccines listed below:

- Diphtheria, pertussis, tetanus
- Haemophilus influenzae type b
- Polio (inactivated)
- MMR
- Varicella

Additional immunisation schedules

You should know the additional requirements in relation to:

- Hepatitis B
- Tetanus
- Influenza

For healthcare workers and patients exposed to susceptibility via accident or illness.

Sources of information

You should consult the following Health Protection Agency website for up-to-date information:

http://www.hpa.org.uk/infections/topics_az/vaccination/vacc_menu.htm

Part B: Specific pathogen groups

Section 1: Streptococci and Staphylococci

Streptococci

You should know the principal clinical features and methods of spread of infection with both:

- *Streptococcus pneumoniae*
- *Streptococcus pyogenes*

As type examples of streptococci

Staphylococci

You should know the principal clinical features and methods of spread of infection with both:

- *Staphylococcus aureus*
- *Staphylococcus epidermidis*

As type examples of staphylococci

Alpha-haemolytic streptococci

The role of these organisms in endocarditis and the need for procedural prophylaxis

Section 2: Tuberculosis

Tuberculosis remains a significant disease and knowledge of its pathogenesis is important.

Transmission and establishment in host

- Appreciation of its aerosol transmission
- Awareness that resistance depends upon T-cell function
- Reactivated disease risk if immunity falls in later life
- Role of the intense immune response in generating lung cavitation and systemic effects

Clinical features

- Appreciation of the broad palette of clinical manifestation
- Particular knowledge of its clinical effects on the lung, kidneys, spine, gut and CNS
- The possibility of miliary tuberculosis in the absence of active lung infection

Laboratory identification

- Simple overview of the roles of ZN stain and nucleic acid amplification techniques

Management

- Knowledge of the standard drug regimen for treatment of tuberculosis
- Particular needs of high-risk patients (eg HIV0 in terms of long-term prophylaxis)
- Knowledge of non-tuberculous mycobacteria is NOT required

Section 3: Clostridial infection

Emphasis here is on the effects of *C difficile*, *perfringens* and tetani

Clostridial colitis

- Normal location of *C difficile* in the body and the role of antibiotics in triggering infection
- Appreciation of the enterotoxin-mediated nature of its effects and variable virulence
- Clinical features of infection
- Nursing and medical aspects of treatment: principles of isolation and drug therapy

Clostridial gas gangrene

- Role of devitalised wounds in harbouring *C perfringens* spores
- Clinical features of infection
- Principles of treatment and prevention

Tetanus

- Role of dirty or devitalised tissue in harbouring spores
- Appreciation of the role of tetanospasmin
- Clinical features of infection
- Principles of treatment and infection (including immunisation schedule in UK)
- Botulism is NOT required knowledge

Section 4: Neisseria

This section focuses on the basis of gonorrhoea and Neisserial meningitis

N. meningitidis

- Simple epidemiological overview: normal carriage; peaks of infection; usual serotypes
- Basis of infection as being via capsule – complement activation – cytokine release
- Clinical features of infection
- Basis of diagnosis: blood culture/ CSF/ rash aspirate
- Medical management of infection: appropriate antibiotics
- Principles of prevention: vaccination; protection of close contacts

N gonorrhoeae

- Appreciation of the epidemiological extent of infection in the community
- Basis of infection as being via adherent pili provoking localised inflammation
- Clinical features of infection
- Basis of diagnosis: pus borne on specialised media; gram stain; serology
- Medical management of infection: contact tracing; public health implications

Section 5: Pertussis

- Appreciation of the epidemiology of whooping cough and nature of its epidemics
- Basis of infection as being via adhesive elements and exotoxins
- Clinical features and possible complications
- Basis of diagnosis: pernasal swab; culture; serology
- Medical management of infection: appreciation of limited role for antibiotics

Section 6: Klebsiella and enterobacteriae

- These three types of infection are chosen as representatives of the enterobacteriae

Klebsiella

- Epidemiology of infection: hospitals; links to critical care areas and ventilators
- Sites of infection: lung; nasal tract; high mortality of Klebsiella pneumonia
- Medical management of infection

Salmonella

- Appreciation of the range of salmonellae but that *S enterica* is the primary pathogen
- Sources of infection: animals, carriers; nature of spread
- Clinical features of infection: gastrointestinal; enteric fever; osteomyelitis; complications
- Treatment of infection: principles of disease prevention and containment

Escherichia coli

- Range of possible infective sites: urinary tract, CNS as examples
- Adaptations of *E coli* promoting its virulence in causing urinary tract infection
- Appreciation of the role of *E coli* in neonatal and post-operative meningitis
- Treatment of infection

Section 7: Gram-negative gastrointestinal disease

This section focuses on *H pylori* and *Campylobacter* as type examples.

Helicobacter pylori

- Basis of infection: role of secreted urease in elevating pH and preventing attack
- Clinical features of infection: asymptomatic state; gastritis; links to ulcers and carcinoma
- Basis of diagnosis: biopsy; urea breath test; stool/ serum antigen
- Principles of medical management

Campylobacter

- Epidemiology: sources of infection; *C jejuni* as the primary human pathogen
- Basis of infection: mucosal colonisation; link to Guillain-Barre syndrome
- Clinical features of infection: gut and systemic features; risk of arthritis
- Basis of diagnosis: faecal sampling
- Principles of management and control: the limited role for antibiotics

Section 8: Legionella

The focus here is on *L pneumophila* as the primary pathogen in human disease

Background to infection

- Role of warm water and sources of moist heat
- Transmission routes via aerosol
- Role of previous morbidity in encouraging infection

Clinical features of infection

- Range of severity; commonly involved systems
- Basis of diagnosis
- Culture of sputum or alveolar aspirate
- Role of serum antibodies

Medical management of infection and principles of prevention and public health

Section 9: Pseudomonas

Pseudomonas receives its own section to reflect the morbidity associated with poor management of infection.

- Appreciation of *P aeruginosa* as being the primary human pathogen
- Role of moist environments within hospitals as being a potent source of pathogen
- Basis of infection as being via cytotoxins and damaging proteases
- Clinical features of infection: eye; ear; skin; bone; CNS; risk of septicaemia
- Basis of diagnosis via culture
- Principles of treatment: appreciation of high resistance to antibiotics
- Implications of *pseudomonas* infections within the hospital setting

Section 10: Chlamydia

Required knowledge here relates primarily to *C trachomatis* but you should be aware that *C psittaci* and *C pneumoniae* are respiratory pathogens capable of causing severe pneumonia, as may *C trachomatis*.

Chlamydial infections of the genital tract and eye

- Features of chlamydial ophthalmia neonatorum: risk of subsequent pneumonitis
- Features of chlamydial genital infection: principles of drug treatment

See also later summary section in relation to genitourinary disease

Section 11: Herpes simplex and zoster

Simplex and varicella zoster are the type examples of herpesviruses which form required knowledge.

You should, however, be aware of the fact that the herpes family encompasses cytomegalovirus and Epstein-Barr virus, although the specific features of these two viruses are not required.

Herpes simplex

- Epidemiology: mode of transmission; problems encountered in the immunocompromised
- Clinical features of infection: differentiation of clinical features of HSV-1 and 2
- Basis of diagnosis: the role of imaging in herpes encephalitis
- Treatment options, in particular the management of encephalitis

Varicella zoster

- Epidemiology: patterns of disease; incubation; dormancy of virus
- Clinical features of infection: chronology of skin changes; VZV pneumonia; shingles
- Basis of diagnosis: appreciation of the fact that diagnosis is essentially clinical
- Treatment: role of acyclovir; role of immune globulin in pregnancy

Section 12: HIV

- Epidemiology: susceptibility to infection; lifestyle factors; materno-fetal transmission
- Pathogenesis: predilection for CD4 cells; mediation via T-cell depletion; CD4 count
- Clinical features: typical course of events following HIV infection
- Co-existent infections: you should be aware of the common infections in HIV patients
- Basis of diagnosis: role of counselling; detection of specific antibody
- Basis of management: simple overview *only* of the principles of treatment
- Minimising replication; prevention of viral resistance; repair of the immune response

Section 13: Hepatitis

Hepatitis A

- Epidemiology: transmission routes; relation of age to chance of infection
- Relation of clinical features to presence of virus in blood/ faeces & derangement of LFTs
- Typical clinical features
- Basis of diagnosis as being via anti-HAV IgM and its persistence in blood
- Standard medical management and measures to reduce transmission rates

Hepatitis B

- Epidemiology and pathogenesis: an appreciation of HbsAg, HbcAg and HbeAg
- Typical modes of transmission and available modes of immunisation
- The role of HDV (hepatitis D) in determining clinical course
- Clinical features of infection: incubation; relation to transaminase levels; complications
- Basis of diagnosis as being via immunoassay
- Overview only of treatment options: interferons; antiviral therapies

Hepatitis C

- Epidemiology: seroprevalence rates and transmission modes
- Clinical features of infection: awareness that many cases are very mild but not all
- Basis of diagnosis as being via immunoassay
- Medical management: ribavirin, interferon; indications for transplantation
- Knowledge of hepatitis D (other than that outlined above) or E is NOT required.

Section 14: Measles, mumps and rubella

For each of measles, mumps and rubella the following are required knowledge:

Epidemiology

- Common modes of transmission
- Incubation period and the relation of infectivity to rash
- Relation of infection to subsequent immunity

Usual clinical features

- Significant complications of each virus (eg measles SSPE)

Vaccination

- Normal UK immunisation schedule

Congenital rubella

- Common clinical features
- Risks to the fetus from infection in 1st, 2nd & 3rd trimesters

Section 15: Respiratory viruses

Rhinovirus

Epidemiology

- Appreciation of the vast range of serotypes

Usual clinical features

- Relation of viral excretion to symptomatic phase

Basis of diagnosis

- Appreciation of its clinical basis

Basis of immunity

- Understanding of the role of multiple serotypes

Influenza and parainfluenza

Epidemiology

- Appreciation of antigenic shifts as cause of epi/pandemics

Usual clinical features

- Incubation period; symptoms; complications

Basis of diagnosis

- Understanding of this being essentially clinical

Principles of management

- Role of influenza vaccine – indications

RSV (respiratory syncytial virus)

- Appreciation of its predilection for children; basis of spread; typical clinical features
- Medical management; role of ribavirin in the severely ill

Section 16: Gastrointestinal viruses

Rotavirus

Epidemiology

- Relation to childhood; seasonal peaks

Pathological basis

- Role of sloughed infected enterocytes; basis of diarrhoea

Diagnosis

- Understanding of this being via NAAT

Principles of management

- Symptomatic nature of treatment

Norovirus

Epidemiology

- Modes of transmission; implications for hospitals

Pathological basis

- Role of small bowel epithelium as a viral host
- Typical clinical features

Diagnosis

- Importance of diagnosis for public health purposes

Section 17: Yeasts and Fungi

Candida

- Appreciation of the presence of *Candida* spp as part of normal flora
- Relation of immunocompromise and antibiotic usage to infection with *Candida*
- Typical local and systemic features of infection; implications of line infections
- Limitations of laboratory identification: its necessary correlation to clinical features

Cryptococcus

- Association with pigeon fanciers; implications of infection in patients with lymphoma
- Typical clinical features
- Basis of therapy: usual drug agents

Dermatophytes

Knowledge here is restricted to the anthrophilic group – see below for detail

- Basis of transmission as being via close personal contact
- Typical features of tinea corporis, capitis and pedis
- Basis of diagnosis as being via skin, hair or nail clippings or scrapings
- Principles of management as being topical and occasionally systemic

Section 18: Worms

Threadworm

- Appreciation of the cycle of infection based upon habitation of large intestine
- Typical clinical features: basis upon which scratching contributes to spread of infection
- Principles of management: typical agents; implications of family-wide infection

Tapeworms (pork & beef)

- Epidemiology: relation to food hygiene
- Basis of infection as being related to taenia egg ingestion followed by hatching
- Typical clinical features

- Basis of diagnosis: visualisation in stool sample; need for imaging (eg CT)
- Principles of management: appreciation of the need for specialist advice

Roundworms and hookworms

- Epidemiology: role of poor sanitation; appreciation of the migratory cycle via liver/lung
- Basis of infection: relation between parasite load and symptom severity
- Typical clinical features
- Basis of diagnosis: visualisation in stool sample
- Awareness (detail not required) of need for imidazole therapy

Section 19: Malaria

Epidemiology

- Role of mosquito bites as a source of sporozoa
- Role of hepatocytes and infected red blood cells
- Basis of dormancy in vivax and ovale

Usual clinical features

- Need for low index of suspicion in returning travellers
- Particular clinical issues of falciparum

Basis of diagnosis

- Understanding of need for serial blood films

Therapy

- Appreciation of the need for specialist advice

Detailed knowledge of drug regimens is NOT required

Section 20: Final notes

This curricular document has shown you where to focus your learning in relation to microbiology.

The clinical aspects of disease caused by the pathogens listed above demand separate study.

Where you encounter symptoms and signs suggestive of infection, take the opportunity to read around the clinical picture to try and identify the likely pathogens.

By regularly looking beyond the shop floor management, and taking the time to learn the basic scientific principles underlying the patient's presentation, you will enrich your understanding of why a given symptom or sign occurs and will have a better appreciation of how best to treat it.

5. Summary of the pathology curricular content

The candidate needs to have a good understanding of the general pathological processes which present to the Emergency Department or underpin nationally accepted guidelines. The majority have already been addressed in the Pathophysiology section. The remaining include:

5.1 Inflammatory response

- Normal v Abnormal
- Inflammatory markers:
 - CRP
 - Rheumatoid factors
 - ANF

5.2 Immune response

- Normal
- Abnormal
 - Hypersensitivity including anaphylaxis & anaphylactoid reactions

5.3 Infection (see also section 4, part b)

The candidate should know the typical causes, pathological processes and investigation of the following infections presenting to an ED:

- Upper respiratory tract
- Lower respiratory tract & pneumonia
- Meningitis & encephalitis
- Myocarditis & endocarditis
- Hepatitis
- Gastro-enteritis
- Urinary tract infection
- STD
- PID
- Cellulitis
- Infection of bones & joints
- AIDS
- PUO
- Malaria
- Fungal infection

5.4 Wound healing

- General principles
- Specific tissues:
 - Skin
 - Tendon
 - Peripheral nerve
 - Bone
 - Myocardial
 - Brain

5.5 Haematology

- Anaemia – classification, causes, investigation
- Leukaemia – classification; acute and chronic lymphoblastic leukaemia; acute and chronic myeloid leukaemia
- Lymphoma and myeloma
- Coagulation – platelet disorders, inherited and acquired coagulation disorder, thrombophilia

6. Summary of the Evidence based Medicine curricular content

The candidate will know the definition of evidence based medicine and:-

- Understand the application of statistics in scientific medical practice
- Understand the advantages and disadvantages of different study methodologies (randomised controlled trials, case controlled cohort etc)
- Understand the principles of critical appraisal