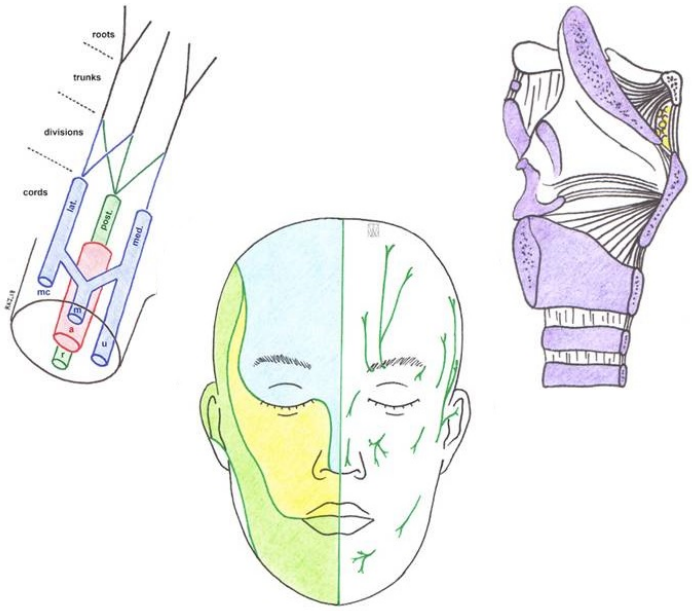
Anatomy for the FRCA Course

6th May 2022

Faculty Pack



Anatomy for the FRCA
Course Programme

09:00 - 09:15	Faculty Brief - Review of Course & Plan for Teaching (MRC)
09:15 - 09:30	Welcome & Introduction (MRC)
09:30 - 10:30	Pre-course Questions Review (ARC)
10:30 - 11:15	OSCE (DR)
	Pre-scan (ARC; for anaesthetists in sonoanatomy session)
11:15 - 11:30	Break
11:30 - 12:30	OSCE Review (DR)
12:30 - 13:00	Lunch (3rd Floor Meeting Room)
13:00 - 13:30	SOE Brief (DR)
13:30 - 15:00	SOEs (DR)
15:00 - 15:15	Break
15:15 - 16:45	Sonoanatomy for Regional Anaesthesia (ARC)
16:45 - 17:00	Summary, Closing Questions & Feedback (MRC)

Anatomy for the FRCA
Course Overview

Faculty review of course & Plan for Teaching (MRC; 15 minutes)

- Review plan for teaching with faculty and ensure allocation of teaching pairs etc
- During this time the candidates will be registering (in the lobby) and marking pre-course MCQs

Welcome & Introduction (MRC; 15 minutes)

- Introduction to candidates: housekeeping, outline aims of course & anatomy in the FRCA

Pre-Course Questions Review (ARC; 60 minutes)

- Two examiners to each station: one anatomist and one anaesthetist
- Candidates cycle round circuit of three stations in small groups
- Tutorial-based approach to review each CRQ for 15 minutes (3 x 15 minutes = 45 minutes)
- During the final 15 minutes of this hour: faculty move through to DR to review OSCE material

OSCE (DR; 60 minutes)

- 6 OSCE stations (each one lasting 7 minutes)
- Candidates spend this hour going round the circuit on their own
- Faculty who will be scanning in the sonoanatomy session (15:45 - 16:45) will go to the ARC to 'pre-scan' their volunteer
- Faculty not scanning can invigilate OSCE/review the material for the next teaching session

OSCE Review (DR; 60 minutes)

- Two examiners to each station: one anatomist and one anaesthetist
- Candidates cycle round circuit in small groups to review OSCE stations with faculty
- 9 minutes of discussion for each OSCE station

Lunch

- Faculty to take 30 minutes for lunch
- Second 30 minutes of lunch break: faculty return to DR for SOE brief

SOEs (DR; 3 x 30 minutes)

- Two examiners to each station (1, 2 or 3): one anatomist and one anaesthetist
- Candidates cycle round 3 x 30 minute SOE stations in pairs (A & B)
- Verbal questioning with use of cadaveric material, models & images
- Each question to last 7 (as per the Final FRCA SOE), followed by 7 minutes for feedback
- Equal time allocation for questions and feedback to emphasise important teaching component

- Candidate A: question (7 minutes), then feedback (7 minutes), whilst candidate B listens in
- Repeat (question/feedback to candidate B, whilst candidate A listens)
- Candidates then move to next station and faculty stay where they are (doing 3 x 30 minutes on same material)

Sonoanatomy for Regional Anaesthesia (ARC; 60 minutes)

- Review of relevant ANATOMY for core blocks in regional anaesthesia (not the technique for various nerve blocks etc)
- Two examiners to each station: one anatomist and one anaesthetist
- The anaesthetist will demonstrate the sonoanatomy on volunteers on the image acquired for each block
- For each ultrasound view reviewed by the anaesthetist, the anatomist will demonstrate relevant anatomy on a prosection (these two aspects should run concurrently, not first half of session sonoanatomy and second half protection anatomy)
- Faculty will teach on upper limb, trunk or lower limb for 30 minutes, candidates then rotate to each of the other stations whilst faculty stay where they are and repeat their tutorial twice.

Pre-Course CRQ 1 (Femoral Triangle & Fascia Iliaca Block)

(a) List the contents of the femoral triangle. (2 marks)

1. *Femoral nerve*

Femoral sheath, containing:

2. *Femoral artery (and branches)*
3. *Femoral vein (and tributaries, including long saphenous vein)*
4. *Femoral canal (containing lymphatics/deep inguinal lymph nodes, including node of Cloquet)*

(b) What are the boundaries of the femoral triangle? (4 marks)

Superior	*inguinal ligament*
Lateral	*medial border of sartorius*
Medial	*medial border of adductor longus*
Roof	*fascia lata*
Floor	*iliacus, psoas major, pectinous, adductor longus*

(c) What are the borders of the fascia iliaca compartment? (4 marks)

Anterior	*Fascia iliaca*
Posterior	*anterior surface of iliacus & posts major/their conjoint tendon*
Medial	*linea terminalis/pelvic brim*
Lateral	*inner lip of iliac crest*

(d) What nerves are targeted by a fascia iliac block? (2 marks)

1. *Femoral nerve (L2-4): supplies hip, anterior/extensor compartment of this, skin of anterior thigh/medial leg & medial foot to first MTPJ*

N.B. Obturator nerve (L2-4), supplying hip, medial/adductor compartment of thigh & skin of medial thigh/knee - block is described in fascia iliaca technique, but rarely occurs as the nerve emerges on the medial side of psoas major

2. *Lateral cutaneous nerve of thigh (L2-3): supplies skin of anterolateral thigh*

(e) Why is a large volume of local anaesthetic is required for a fascia iliaca block? (2 marks)

- *It is a compartment block where local anaesthetic is deposited into the plane between the deep fascia overlying the iliacus muscle, where several branches of the lumbar plexus are found (femoral nerve courses through a pocket of the fascia iliaca)*
- *Fluid-filled space is created deep to fascia iliaca/superficial to iliacus muscle, as it increases in size during the injection, fluid travels cephalic beneath the fascia and contacts the nerves mentioned above, therefore a large volume of local anaesthetic is required (e.g. 30 ml)*

(f) Outline how you would perform an ultrasound-guided fascia iliaca block. (6 marks)

1. *Consent*
2. *Stop before you block: confirm side & site*
3. *SLIMRAG:*
    - *Sterile procedure (wash hands, sterile gloves, sterile dressing pack)*
    - *Light source/ultrasound*
    - *IV access*
    - *Monitoring (AAGBI minimum standard)*
    - *Resuscitation drugs/equipment available*
    - *Assistant (who is happy to assist with regional or general anaesthetic*
    - *General anaesthetic: ensure equipment/drugs available to covert if required*
4. *Confirm the safe dose of local anaesthetic pre-procedure (particularly as this is a large-volume block and is frequently performed on patients with a low body weight - care with dosing is advised)*
5. *Position the patient lying, with proximal thigh exposed*
6. *Clean the field with 0.5% chlorhexidine and allow to dry*
7. *Needle insertion 2 cm below the junction of medial 2/3 and lateral 1/3 of the inguinal ligament*
8. *High frequency linear array U/S probe with sterile cover and gel*
9. *Out of plane technique probably better at allowing the operator to ensure needle is deep to the fascia iliaca and avoid nerve or vascular injury by the needle*
10. *Local anaesthetic to skin*
11. *Pass short-bevelled 50 mm needle through fascia lata & fascia iliaca, at an angle of 45° (directed cranially)*
12. *After negative aspiration slowly inject 30 ml local anaesthetic (e.g. 0.25% levobupivacaine), confirming negative aspiration after every 5 ml injection (+/- distal pressure)*

Pre-Course CRQ 2 (Internal Jugular Vein)

(a) Describe the origin, course & termination of the internal jugular vein (IJV). (5 marks)

Origin	*Begins as a continuation of the sigmoid sinus as it emerges through the posterior compartment of the jugular foramen.* *Origin sometimes described as the point where it combines with the inferior petrosal sinus.*
Course (in relation to the carotid artery)	*Lies posterior to the internal carotid artery at the base of the skull (on the transverse process of the atlas).* *As it passes inferiorly in the neck, it comes to lie on the lateral side of the internal carotid artery.* *In the lower neck, the IJV typically lies anterior/anterolateral to the common carotid artery.*
Termination	*Terminates behind the medial end of the clavicle, joining with the subclavian vein to form the brachicephalic vein.*

(b) List 5 features of the jugular venous pulse (JVP) which distinguish it from the carotid pulse. (5 marks)

1. *JVP is impalpable*
2. *JVP has a complex waveform*
3. *JVP fills from the top (if IJV occluded)*
4. *JVP demonstrates the hepatojugular reflux (JVP will transiently rise with hepatic pressure)*
5. *JVP moves with respiration (normally decreasing on inspiration and rising in expiration)*

(c) List 5 indications for cannulation of the internal jugular vein. (5 marks)

1. *Monitoring CVP/RV function/intravascular volume status*
2. *Administration of drugs which cannot be given peripherally (vasoactive drugs/inotropes, vaso-irritant drugs e.g. potassium/amiodarone, TPN, some cytotoxic drugs)*
3. *Blood sampling due to poor vascular access*
4. *Haemodialysis/haemofiltration*
5. *Transvenous cardiac pacing*

Others include:

6. *Insertion of pulmonary artery catheter (or its introducer sheath for large bore IV access +/- rapid fluid administration)*
7. *Aspiration of air embolus from right hand side of the heart*
8. *Jugular venous bulb saturation measurement*

(d) List 5 complications of cannulating the internal jugular vein. (5 marks)

Due to needle/at insertion:

1. *Carotid artery puncture (+/- bleeding, dissection, embolus)*
2. *Pneumothorax (or haemothorax)*
3. *Thoracic duct injury (+/- chylothorax)*
4. *Nerve injury (e.g. CN 10, recurrent laryngeal, phrenic)*
5. *Retained guidewire*

Due to line:

6. *Arrhythmia*
7. *Air embolism*
8. *Thrombosis/embolism (+/- vessel stenosis)*
9. *Infection*
10. *Cardiac tamponade/haemopericardium*
11. *Anaphylaxis has been reported from chlorhexidene impregnated catheters*

Pre-Course CRQ 3 (Oesophagus)

(a) Outline the nerve supply of the oesophagus by completing the table below. (3 marks)

*Vagal fibres from the nucleus ambiguus supply upper third striated muscle of the oesophagus, fibres from dorsal motor nucleus for lower visceral muscle

**This explains the referred pain of oesophagitis - retrosternal dermatomes T 2-6

Modality	Origin
Motor	*CN 10*:* *- Recurrent laryngeal nerve (for upper third)* *- Vagal plexi (for rest)*
Sensory	*Pain runs with both parasympathetic (CN 10) and sympathetic fibres** (T2 - T6, from the middle & lower cervical ganglia)*
Secretomotor	*CN 10*

(b) Outline the vascular supply of the oesophagus. (6 marks)

***in 25%, arises directly from the third part of the subclavian artery

Location	Arterial supply	Venous drainage
Cervical oesophagus	*Oesophageal branches of inferior thyroid artery (arise from the thyrocervical trunk - third branch of the first part of the subclavian artery***)*	*Inferior thyroid vein (draining to brachiocephalic vein; **systemic circulation**)*

Thoracic oesophagus	*Oesophageal branches of thoracic aorta*	*Azygos vein (draining to SVC; **systemic circulation**)*
Abdominal oesophagus	*Oesophageal branches of the left gastric artery*	*Oesophageal tributaries of the left gastric vein (draining to **portal vein**)*

(c) List eight relations of the thoracic oesophagus. (4 marks)

Anterior

12. *Trachea*

13. *Left main bronchus*

14. *Pericardium(/left atrium)*

15. *(Left) recurrent laryngeal nerve*

16. *Anterior vagal trunk*

Posterior

1. *Vertebral bodies*

2. *Thoracic duct (crossing to the left at T5)*

3. *Descending thoracic aorta*

4. *Connections to (accessory)/hemiazygos vein*

5. *Posterior vagal trunk*

Right

1. *Pleura(/right lung)*

2. Azygos vein

Left

1. Arch of aorta

2. *Thoracic duct (above T5)*

(d) List 3 anaesthetic devices that are placed in the oesophagus & state their function. (3 marks)

Device	Function
Oesophageal Doppler	*Monitor cardiac output*
Transoesophageal echocardiography probe	*Assess cardiac structure/function & fluid status*
Oesophageal temperature probe	*Measure core temperature*
Nasogastric tube	*Enteral feeding/gastric aspiration*
Oesophageal contractility monitor	*Monitor depth of anaesthesia)*

(e) List 4 features of the distal oesophagus and the surrounding structures that form the 'physiological sphincter' of the lower oesophagus. (4 marks)

1	Tonic contraction of circular smooth muscle in the lower oesophagus
2	*Fibres of the right crus of the diaphragm surround the lower oesophagus*
3	*Longitudinal folds of oesophageal mucosa occluding the central lumen*
4	*The oesophagus enters the stomach at an acute angle*
5	*The terminal 2-3 cm of the oesophagus are below the diaphragm (raised intra-abdominal pressure compresses the oesophagus causing a flap-valve effect)*

*(**N.B.** Gravity is also a contributing factor when upright - hence why patients may experience gastro-oesophageal reflux disease predominantly when lying down (e.g. when going to bed))*

Pre-Course MCQ Answers

Internal auditory meatus: **TTFFT**

Anterior spinal artery syndrome: **TTTFT**

Oesophagus: **FTTFT**

Trachea: **FFTFF**

- Left vagus nerve and trachea separated by the aorta
- Thoracic duct lies behind the oesophagus/left main bronchus

Internal jugular vein: **FFTTF**

- Jugular foramen lies in posterior cranial fossa
- Joins the SCV to form the brachiocephalic vein

Radial nerve: **TFTTF**

Lumbar plexus: **FTFFF**

- Receives a contribution from T12 in half the population
- Stimulation of the femoral nerve/contraction of the quadriceps
- Lateral cutaneous nerve of the thigh is purely sensory

Superior & inferior orbital fissures: **TFTFT**

Bronchial circulation: **TFFFT**

Oesophageal pathology: **FTTTT**

CN XII: **FFFFT**

Axillary brachial plexus block: **FTFFF**

Anterior triangle of neck: **TTFTT**

- Contains the IJV (not EJV)

Hilum of the left lung: **TTFTT**

Oesophageal sphincters: **TTTFT**

Brown-Séquard syndrome: **FTFTT**

- Flaccid paralysis at the level of the lesion

Ulnar nerve: **FTTFT**

Carotid sheath: **FTFTT**

- Contains the CCA/ICA

OSCE Station 1
(Larynx)

Name structures A - D on this model/specimen (4 marks)

A) Epiglottis (elastic cartilage)
B) Thyroid cartilage (hyaline cartilage)
C) Cricoid cartilage (hyaline cartilage)
D) Arytenoid cartilages (hyaline cartilage)

Now name structures E - I (5 marks)

E) Thyrohyoid membrane
F) Cricothyroid membrane
G) Aryepiglottic fold
H) Vestibular fold (false cords)
I) Cricovocal membrane (upper edges form the true vocal cords)

Describe the innervation of the larynx, demonstrate this on the model (3 marks)

- Superior laryngeal nerve:
  - Internal branch (sensation above vocal cords: from dorsum of epiglottis to cords)
  - External branch* (motor supply to cricothyroid)
- Recurrent laryngeal nerve:
  - Sensation below the vocal cords
  - Motor supply to all intrinsic muscles of the larynx except cricothyroid

*Occasionally also supplies the cricopharynxgeus part of the interior constrictor of the pharynx

How might injury to the vagus nerve or its branches affect the larynx? (4 marks)

- Superior laryngeal nerve**: reduced vocal cord tension, hoarse voice
- Recurrent laryngeal nerve:
  - Complete lesion: ipsilateral vocal cord adopts a position midway between abduction/adduction
  - Partial lesion***: ipsilateral vocal cord adopts a midline/adducted position (because adductors stronger than abductors)

**Reduced sensation in the upper larynx also poses an aspiration risk

***Bilateral partial lesions lead to **complete airway obstruction** as both cords adopt the midline position (Semon's law)

How can you anaesthetise the larynx for an awake fiberoptic intubation? (4 marks)

- Nebulised lidocaine
- Topical local anaesthetic using a mucosal atomiser device (nasal mucosa, naso-/oro-/laryngopharynx)
- 'Spray as you go' (laryngopharynx, larynx, trachea)
- Translaryngeal approach**** (cricothyroid puncture) is sometimes used
- Nerve blocks: anterior glossopharyngeal, superior thyroid (rarely used)
- Cocaine-soaked pledglets (again, rarely used)
- Co-administration of sedation can reduce local anaesthetic requirement (e.g. TCI propofol or remifentanil)

****Introduces local anaesthetic to the lower airway by inserting a needle through the cricothyroid membrane and injecting - asking the patient to take a deep breath takes the local anaesthetic into the lower airway and often precipitates coughing, which further disperses the anaesthetic around the upper airway

OSCE Station 2
(Rectus Abdominis, Sheath & Rectus Sheath Block)

Name muscle A, describe it's origin and insertion (3 marks)

- Rectus abdominis muscle
- Origin: pubic crest (lateral head) & pubic symphysis (medial head)
- Insertion: anterior surface of 5th, 6th & 7th costal cartilages

Describe the level of the tendinous intersections which give this muscle its classical appearance. To which layer of the rectus sheath are they adherent? (2 marks)

- Upper: at the level of the xiphoid process
- Middle: midway between xiphoid process and umbilicus
- Lower: at the level of the umbilicus
- Adherent to anterior layer of sheath (visible through skin of lean individuals - '6 pack')

Describe the layers and contents of the rectus sheath (6 marks)

- Layers (in relation to rectus abdominis):
  - Above costal margin:
    - Anterior: aponeurosis of external oblique only
    - Posterior: ribs/costal cartilages only (no sheath)
  - Costal margin to arcuate line:
    - Anterior: aponeuroses of internal oblique (anterior lamella) and external oblique
    - Posterior: aponeuroses of internal oblique (posterior lamella) and transversus abdominis
  - Below arcuate line (around halfway between umbilicus and pubic symphysis):
    - Anterior: aponeuroses of all three muscles
    - Posterior: transversals fascia (no sheath)
- Contents:
  - Rectus abdominis muscle (and pyramidalis muscle when present - around 80%)
  - Superior and inferior (deep) epigastric arteries, with their accompanying veins
  - T7-11 thoraco-abdominal & T12 (subcostal) nerves, with their accompanying vessels (motor to rectus abdominis; sensory to parietal peritoneum, muscle and overlying skin)

Describe the regions of the following dermatomes (3 marks)

- T10: umbilicus
- L1: inguinal ligament
- T7: xiphoid process

Describe how you would perform a rectus sheath block (6 marks)

- Consent
- Stop before you block: confirm side and site (usually bilateral)
- SLIMRAG:
  - Sterile procedure (wash hands, sterile gloves, sterile dressing pack)
  - Light source/ultrasound
  - IV access

Block tips…

If inserting a rectus sheath catheter, an 18 G Tuohy needle provides excellent U/S visibility and allows passage of an appropriately sized catheter

  - Monitoring (AAGBI minimum standard)
  - Resuscitation drugs/equipment available
  - Assistant (who is happy to assist with regional or general anaesthetic
  - General anaesthetic: ensure equipment/drugs available to convert if required
- Position the patient supine, exposed from costal margin to inguinal ligament
- Clean the field with 0.5% chlorhexidine (allow to dry)
- High frequency linear array U/S probe with sterile cover and gel
- Place the probe in the midline (midway between the xiphisternum and umbilicus), aligned transversely, then scan laterally:
  - Off the midline is the oval appearance of the rectus abdominis muscle
  - Two echogenic layers on posterior surface: posterior rectus sheath and peritoneum (with intervening transversalis fascia appearing dark)
- In plane technique, 80 mm short bevel regional block needle: inserted from lateral (directed medially) aiming for the needle tip lie in the potential space between the muscle and posterior wall of the rectus sheath
- After negative aspiration, slowly inject 20 - 30 ml local anaesthetic on either side (depending on dose calculation), confirming negative aspiration after every 5 ml injection

OSCE Station 3
(Blood Supply to UL)

Identify structures A-E in this cadaver (5 marks)

A) Axillary artery
B) Radial artery
C) Brachial artery
D) Deep palmar arch
E) Superficial palmar arch

Name the artery running with the following nerve (3 marks)

1) (Radial nerve in the proximal arm) profunda brachii artery
2) (Median nerve in the cubital fossa) brachial artery
3) (Ulnar nerve at the wrist) ulnar artery

Describe the collateral arterial supply of hand (8 marks)

- Supplied from radial and ulnar arteries (arise from the brachial artery at the level of the neck of the radius, in the cubital fossa)
- They enter the hand to form two arterial arches: superficial (principally from the ulnar) and deep (principally from the radial)
- Radial artery:
  - Palpable at the wrist, then continues through the anatomical snuff box as the 'deep branch' to form the deep palmar arch (which is completed by the deep branch of the ulnar artery)
  - Gives a superficial branch 2 cm proximal to the wrist crease (passes over the flexor retinaculum, through the thenar muscles and contributes to the superficial arch)
- Ulnar artery:
  - Palpable at the wrist, then continues over the flexor retinaculum (in canal of Guyon) to form the superficial palmar arch (completed by the superficial branch of the radial artery)
  - Gives a deep branch (through the hypothenar muscles) which contributes to the deep arch
- Palmar arches:
  - Superficial: supplies medial 3½ digits via palmar digital arteries (cf. opposite to the ulnar nerve distribution, which provides sensory supply to the medial 1½ digits)
  - Deep: supplies the lateral 1½ digits via princeps policis and radialis indicis arteries (cf. median nerve provides sensory suppled to the lateral 3½ digits)
  - The two arches are also linked by metacarpal arteries

What is Allen's test? (4 marks)

- Used before attempting cannulation of the radial artery
- Test to assess adequate ulnar collateral supply to the hand
- Compress radial and ulnar arteries at the wrist
- Elevate hand and make a fist for 30 seconds
- When opening the hand and the hand is pale (due to limited arterial supply)
- Release the ulnar artery: colour should return to the hand within 10 seconds
- Poor ulnar arterial supply is indicated if this is prolonged
- (The accuracy of this test is questioned)

OSCE Station 4
(Dural Venous Sinuses)

Name structures A-E on this image/specimen (5 marks)

D) Superior sagittal sinus
E) Inferior sagittal sinus
F) Straight sinus
G) Left transverse sinus
H) Right sigmoid sinus

What drains to and from structure F? (5 marks)

- Structure F: cavernous sinus
- Receives: ophthalmic veins (superior and inferior), cerebral veins (superficial middle cerebral +/- inferior cerebral), sphenoparietal sinus
- Drains to: petrosal sinuses (superior and inferior)
- N.B. The intercavernous sinuses (anterior and posterior) communicate between the two cavernous sinuses, and emissary veins connect the cavernous sinus and pterygoid venous plexus below

What structures lie within structure F? (5 marks)

- Within the sinus:
  - Internal carotid artery (carrying postganglionic sympathetic fibres of the internal carotid plexus, including those for dilator pupillae and levator palpebrae superioris)
  - CN 6
  - (Venous blood)
- In the lateral wall:
  - CN 3
  - CN 4
  - CN 5.1 & 5.2

What are the clinical features of thrombosis of structure F? (5 marks)

- Features of raised ICP:
  - Symptoms: headache, nausea/vomiting, falling level of consciousness, seizures
  - Signs: papilloedema, dropping GCS, CN 3/6 palsy
- Features related to the cavernous sinus anatomy:
  - CN 3 - 6 palsies
  - Impaired venous drainage of the eye (proptosis, chemosis & injected eye)

OSCE Station 5
(Coronary Circulation)

Name structures A-D on this specimen (4 marks)

A) Left coronary artery
B) Anterior interventricular/left anterior descending artery
C) Right (acute) marginal artery
D) Posterior interventricular/descending artery

Now name structures E-H (4 marks)

E) Coronary Sinus
F) Great cardiac vein
G) Middle cardiac vein
H) Small cardiac vein

Nomeclature relating to the coronary sinuses:

- *Foetal position: right (RCA), left (LCA), posterior (non-coronary)
- **Adult position: anterior (RCA), right posterior (non-coronary), left posterior (LCA)

The foetal terminology is typically used in clinical practice

From where do the main coronary arteries arise? (2 marks)

- RCA: right* (anterior**) aortic sinus (of ascending aorta)
- LCA: left* (left posterior**) aortic sinus (of ascending aorta)

What proportion of the cardiac output is supplied to the myocardium? (1 mark)

- 5% or 250 ml/min (can increase fivefold during exercise)

What is meant by coronary arterial dominance? (1 mark)

- This is defined by the vessel that gives rise to the posterior interventricular artery (usually RCA), as this is turn gives rise to the AV nodal artery

Which artery supplies the AV node and where does it arise from? (2 marks)

- AV nodal artery
- In >80% it is from the RCA, in 10% is a continuation of the circumflex branch of the LCA
- <10% have a 'balanced' circulation where the is AV node is supplied by both the RCA & circumflex (LCA): branches of both sides run in or near the posterior interventricular groove)

Which artery supplies the SA node and where does it arise from? (2 marks)

- SA nodal artery
- In 60% it arises from the RCA, in 40% from the circumflex artery (LCA)

What are the ECG features of right coronary artery occlusion? (2 marks)

- Inferior MI: features in leads II, III & aVF
- ST segmental elevation (subsequent development of Q waves)
- (Reciprocal ST depression in aVL +/- V1)
- Other features: heart block, RBBB

Describe the difference between a type I and type II acute myocardial infarction? (2 mark)

- A type I MI described focal myocardial ischaemia/necrosis resulting from a lesion in specific coronary artery (most commonly rupture of an atheromatous plaque)
- A type II MI describes myocardial ischaemia/necrosis from an oxygen supply/demand mismatch (e.g. secondary to fast AF/severe tachycardia and hypotension), a coronary abnormality may not be present

OSCE Station 6
(Ankle Block)

Name the nerves labelled A-E. Describe their area of cutaneous innervation (10 marks)

A) Tibial*
- Lies posterior to the medial maleolus, typically posterior to the posterior tibial artery**
- Gives medial calcaneal branches, which pierce flexor retinaculum to supply the skin of the heel (including weight-bearing surface)
- Divides into the medial and lateral plantar nerves in the foot (under flexor retinaculum) which provide cutaneous innervation to the sole of the foot (medial 3½ toes and lateral 1½ toes respectively)***
- Also supplies skin over distal phalanges

B) Saphenous
- Largest sensory branch of the femoral nerve
- Below the knee it travels with the great/long saphenous vein
- Sensation to medial calf and medial aspect of the ankle/foot (as far as first MTPJ - 'bunion area')

C) Sural
- Formed by the union of branches of the tibial and common peroneal nerves
- Below the knee if travels with the small/short saphenous vein
- Passes *posterior* to the lateral malleolus (cf. saphenous nerve & GSV lie *anterior* to the medial malleolus)
- Innervation to the lateral aspect of the calf, ankle and foot (including little toe)

D) Deep peroneal/fibular
- Common peroneal divides into superficial and deep branches within peroneus longus
- Deep nerve provides sensory supply to 1st web space

E) Superficial peroneal/fibular
- Pierces deep fascia in the distal third (between middle and distal thirds) of the leg (emerges between extensor digitorum longus and peroneus brevis)
- Sensation to lower half of anterolateral leg and ankle, dorsum of the foot via medial and lateral branches

*There is no *posterior* tibial nerve! (This terminology has been replaced, it is now simply the tibial nerve, but is still seen in clinical texts)

**Mnemonic for the structures behind the medial malleolus (from anterior to posterior):

'**T**om, **D**ick **A**nd **V**ery **N**aughty **H**arry'

Tibialis posterior, F**D**L, posterior tibial **A**rtery & **V**ein, tibial **N**erve, F**H**L

***Aide memoire for distribution of plantar nerves: medial plantar like median nerve on palm of the hand, lateral plantar like ulnar nerve

Identify structures F-I (4 marks)

F) Achilles tendon
G) Dorsalis pedis artery
H) (Inferior) extensor retinaculum
I) Small/short saphenous vein

Which of these nerves lie superficial to deep fascia at the level blocked? (3 marks)

- Saphenous
- Superficial peroneal/fibular
- Sural

From time of injection to onset of block, which of these nerves classically takes the longest and why? Which of these nerves can be identified with a nerve stimulator? (3 marks)

- Tibial takes the longest as it is the largest nerve
- Tibial nerve provides all of the motor innervation to the foot except for extensor digitorum brevis and extensor hallucis brevis (Deep peroneal/fibula). Saphenous, superficial peroneal/fibular & sural are sensory branches at this level.

SOE 1

1.1 Orbit

1.2 Foetal circulation

1.1 Orbit (SOE)

On this skull, demonstrate and describe the bony structure of the orbit

- Four-sided pyramid, lying on its side
- The base lies anteriorly & apex posteriorly (on the optic canal/medial end of the superior orbital fissure)
- Medial walls lies in parallel & lateral walls diverge at 90° (continuing these lines posteriorly, they would meet at the pituitary fossa)*
- Roof:
  - Orbital plate of frontal bone
  - Lesser wing of sphenoid
- Floor:
  - Orbital surface of maxilla
  - Partly by zygomatic and palatine bones
- Medial wall:
  - Orbit plate of ethmoid bone (lamina papyracea)
  - Contributions from the maxilla, lacrimal and sphenoid
- Lateral wall (longest, thickest & strongest part of the orbit):
  - Zygomatic bone
  - Greater wing of sphenoid

*Note that the axes of the orbit and globe are different:
- The axis of the orbit bisects the medial and lateral walls, i.e. lies along a plane that runs from posteromedial to anterolateral
- The axis of the globe lies on a direct anteroposterior plane

On this skull, identify features A-E

A) Optic canal
B) Superior orbital fissure
C) Inferior orbital fissure
D) Supraorbital notch
E) Infraorbital groove, canal and foramen

Which areas do A & B run between and what structures do they transmit?

A) Optic canal:
  - Canal through the lesser wing of the sphenoid bone
  - Connect orbit to middle cranial fossa
  - Transmits CN 2 and the ophthalmic artery

B) Superior orbital fissure:
  - Cleft between greater and lesser wings of sphenoid
  - Connects orbit and middle cranial fossa
  - Divided into three compartments by the common tendinous origin/ring (annulus of Zinn) which gives rise to rectus muscles in the orbit
  - Lateral compartment: lacrimal (CN 5.1), frontal (CN 5.1) & trochlear (CN 4) nerves, superior ophthalmic vein
  - Intermediate compartment (within the tendinous ring): oculomotor (CN 3; superior and inferior divisions), abducens (CN 6) and nasociliary (CN 5.1) nerves
  - Medial compartment: inferior ophthalmic vein

1.2 Foetal Circulation (SOE)

Use the following diagram to describe the foetal circulation, starting at the umbilical vein

- Oxygenated blood returns from the placenta via the (left) umbilical vein
- (The right umbilical vein obliterates during foetal development)
- This joins the left branch of the portal vein in the porta hepatis
- Most (>60%) travels to the IVC via the ductus venosus, bypassing the hepatic circulation
- On returning to the right atrium, oxygenated blood from the IVC travels across the foramen ovale to the left atrium
- From the left atrium blood passes to the left ventricle and out into the ascending aorta, perfusing the carotid arteries
- Deoxygenated blood returning from the head and neck via the SVC passes through the right atrium (mixing very little with oxygenated blood from the IVC) to the right ventricle, and out into the pulmonary trunk
- 90% of this blood bypasses the lungs via the ductus arteriosus, which opens into the aorta distal to the three branches of the arch of the aorta (preventing venous blood perfusing the head and neck)
- This deoxygenated blood then travels in the descending aorta and through the common iliac arteries, then (anterior division of the) internal iliac arteries, and finally the umbilical artery to the placenta

Label the diagram with approximate oxygen saturation of blood at the following points

- Umbilical vein - 80%
- IVC - 67%
- Ascending aorta - 62%
- Ductus arteriosus - 50%
- Descending aorta - 58%

What are the physiological changes that occur at birth?

- When the neonate inspires, the expanding and newly oxygenated lung tissue causes a dramatic reduction in pulmonary vascular resistance
- As pulmonary blood flow increases, so does pulmonary venous return
- Clamping of the umbilical cord raises systemic vascular resistance and aortic pressure
- This raises left atrial pressure, causing closure of the foramen ovale
- As the pressure gradient across the left and right side of the circulation reverses, this reduces (or even reverses) blood flow across the ductus arteriosus
- The ductus arteriosus closes via contraction of its muscular wall due to higher partial pressures of oxygen and chemical mediators (e.g. decreasing prostaglandins)
- Obliteration of the ductus arteriosus can take from two weeks to two months

Describe the development and structure of the foramen ovale*

*This version is derived from a particularly excellent description in Ellis & Mahedevan's 'Clinical Anatomy: Applied Anatomy for Students & Junior Doctors' (12th Edition, 2010; p 40-4) - the authors encourage readers to review this account

- At early stages of embryonic development a single atrium is present
- An initial partition grows down from the posterosuperior wall (septum primum) to meet the endocardial cushions which divide the embryonic atria from ventricles
- Before the two atria are completely divided, a perforation develops in the septum primum, the foramen secundum (the foramen primum being the initial communication between the two sides of the atrium)
- A second partition then develops on the right of the septum primum (the septum secundum)
- The septum secundum has a free lower border, but is large enough to overlap the foramen secundum
- This creates a flap valve effect:
  - When the right atrium is at higher pressure, the septum primum deviates to the left, allowing blood to pass through the space between the foramen secundum and septum secundum (from right to left)
  - However, when the left atrium is at higher pressure, the septum primum is compressed against the septum secundum, closing the channel

What is meant by a paradoxical embolus?

- This refers to an embolus which is carried from the venous side of the adult circulation to the arterial side (or vice versa)
- It can cross via a defect in the heart, such as a patent foramen ovale (or ASD/VSD), or via AV shunts in the lungs
- They represent around two percent of emboli

SOE 2

2.1 CN 5 & trigeminal neuralgia

2.2 Cubital fossa & inadvertent intra-arterial injection

2.1 CN 5 & Trigeminal Neuralgia (SOE)

Describe the anatomy of the trigeminal nerve (CN 5)

- Single motor nucleus:
  - Trigeminal motor nucleus (pons; motor to muscles of mastication & 4 others*)
- Three sensory nuclei:
  - Trigeminal mesencephalic nucleus (midbrain; proprioception)
  - Trigeminal pontine (principal) nucleus (pons; touch)
  - Trigeminal spinal nucleus (medulla; pain/temperature)
- Arises from the pons as a large sensory root and a smaller motor root
- The majority of sensory fibres have their cell body located in the trigeminal ganglion** (aka semilunar/Gasserian ganglion), lying within an evagination of arachnoiddura (cavum trigeminale/Meckel's cave) near the apex of the petrous temporal bone in the middle cranial fossa
- Three sensory branches emerge:
  - V1 (ophthalmic): passes forward in lateral wall of cavernous sinus, divides into lacrimal, frontal (further divides: supraorbital & supratrochlear) and nasociliary branches which exit middle cranial fossa through superior orbital fissure
  - V2 (maxillary): passes forward in lateral wall of cavernous sinus, leaves middle cranial fossa through foramen rotundum
  - V3 (mandibular): passes inferiorly through foramen ovale, then joined by motor root to form a trunk which splits into two divisions (anterior is mainly motor & posterior is mainly sensory)

*Muscles supplied by CN 5:
- Masseter
- Temporalis
- Medial pterygoid
- Lateral pterygoid
- Tensor tympani
- Tensor palati
- Anterior belly of digastric

**Equivalent to the dorsal root ganglion of a spinal nerve

On this model, describe the sensory supply of CN 5

- Sensation to face and scalp, from chin to vertex and ear to ear (but not angle of jaw)
- Anterior meninges (dura and arachnoid)
- Eye, nasal and oral cavities (including inside of cheek, mandible, teeth & gums)
- General sensation to anterior two thirds of tongue (but not taste***)

***Supplied by chorda tympani of CN 7

What is trigeminal neuralgia (TN)?

- Episodic, severe, lancinating pain in CN V territory (V1/V2 more common, V3 rare)
- Always unilateral, typically abrupt onset/offset
- May develop allodynia or hyperalgesia (but no other neurological deficit)
- Usually asymptomatic between paroxysms
- May be no clear cause, but have various triggers (e.g. touch, shaving)
- International Headache Society diagnostic criteria (ICHS Classification ICHD-3):
  - Recurrent paroxysms of unilateral facial pain in the distribution of one/more division of CN V, with no radiation beyond, and fulfilling the following criteria:
  - A: lasting up to two minutes + severe + electric shock-like/stabbing/sharp (duration can change over time)
  - B: triggered by innocuous stimuli within the CN V distribution (attacks can be/may appear to be spontaneous, but must be a history of pain provoked by stimuli)
  - C: not better accounted for by another ICHD-3 diagnosis

Risk factors and diagnosis?

- Risk factors:
  - Female (F:M 2:1)
  - Age (rare before 50 years, peak onset 60-70 years)
  - Occurs in 3-4% of patients with multiple sclerosis (often in younger patients)
  - There is an association with hypertension
  - Possibly a familial link (suggested to be a result of inherited blood vessel malformation)
- Diagnosis:
  - Clinical, from the history
  - MRI can help exclude brainstem lesion and vascular malformation

What causes TN?

- Unclear
- Primary/secondary demyelination of CN V leads to uncontrolled firing of small fibres (e.g. secondary demyelination due to compression by one of the cerebellar arteries)
- Occurs partly because of lack of inhibitory input from large myelinated fibres (e.g. in MS, due to blood vessel compressing nerve)
- Central mechanism also suggested

Describe the management of TN?

- Conservative
  - Psychological support may be important for for resistance/poorly responsive cases
- Medical
  - Cabamazepine (effective in >90%, if no response reconsider diagnosis)
  - Phenytoin second line
  - Other agents: gabapentin, amitriptyline, baclofen, clonazepam, lamotrigine
- Surgical/interventional
  - Alcohol injection at various points along the nerve (now rarely performed)
  - Glycerol injection of the trigeminal ganglion (both aim to selectively destroy pain fibres, glycerol technique has higher success rate)
  - Balloon decompression (destroying sensory fibres)
  - Gamma knife techniques (stereotactic-guided radio-ablation: needle passed through foramen oval into trigeminal ganglion, benefit may take months to develop)
  - Open microvascular decompression of CN V (effective in >80%, previously only done if imaging demonstrated a vessel compressing the nerve, but may be effective even if pre-operative imaging does not show this)

2.2 Cubital Fossa & Inadvertent Intra-arterial Injection (SOE)

Demnonstrate the boundaries of the cubital fossa on this cadaver

- Proximal: line joining the medial and lateral epicondyles of the humerus
- Inferolateral: medial border of brachioradialis
- Inferomedial: lateral border of pronator teres
- Roof: deep fascia of forearm (reinforced by the bicipital aponeurosis)
- Floor: brachialis, capsule of elbow joint, supinator muscle

*__TAN__:
- __T__endon
- __A__tery
- __N__erve

The radial nerve is included in some descriptions, lying between brachioradialis and brachialis

Demonstrate the contents of the cubital fossa*

- Biceps tendon
- Brachial artery (dividing into radial and ulnar arteries)
- Median nerve

Name the superficial veins associated with the cubital fossa, the areas they drain and where they drain to

- Cephalic (drains lateral side of forearm, runs up lateral edge of biceps to deltopectoral groove and pierces clavipectoral fascia to drain into the axillary vein)
- Basilic (drains medial side of forearm, runs up medial side of arm and pierces deep fascia half way up the arm, to join the venae commitantes of the brachial artery and form the axillary vein at the inferior border of teres major)
- Median cubital (connect cephalic and basilic veins, lies over the bicipital aponeurosis)
- Variations in the pattern of these veins are common

What are the features of inadvertent intra-arterial injection here

- May be asymptomatic
- The drug may fail to elicit the expected effect
- Pain and paraesthesia (if patient awake) in the hand
- Ischaemic changes (vasospasm): cool, pale, mottled, cyanosed
- May be unable to feel distal pulses (may ultimately develop oedema and tissue necrosis)

Why is intra-arterial injection of thiopentone problematic

- Thiopentone is a thiobarbituate which demonstrates structural isomerism (molecules have same molecular formula but differ in the order in which the elements are arranged)
- In solution it has a pH of 10.4: at this pH it exists as the enol form, which is water soluble
- The pKa of thiopentone is 7.6
- Therefore, at physiological pH 7.34 - 7.45 it transforms into the keto form which is fat soluble and acid crystals precipitate out of solution
- When injected into a vein, this is not significant because the crystals are subject to serial dilution as the blood mixes with that from other veins
- When injected into an artery, the crystals can occlude the vessel and cause intense vasospasm

How would you manage a patient who has just received inadvertent intra-arterial injection of thiopentone?

- No universally agreed protocol: aim to maintain distal perfusion
- Stop injection

- Maintain the arterial cannula in place
- 500 ml warmed fluids through the cannula can dilute the crystals
- Intra-arterial injection of 1% lignocaine may provide analgesia
- 500 - 1000 units heparin through the cannula to reduce the risk of thrombosis
- Treat arterial spasm with papaverine (smooth muscle relaxant), prostacyclin, tolazoline (noradrenaline antagonist) or phenozybenzamine (alpha 1 antagonist)
- Can consider stellate ganglion/brachial plexus block to achieve vasodilation/analgesia
- May need to maintain heparinisation for up to 14 days

SOE 3

3.1 Anterolateral abdominal wall

3.2 Interscalene block

3.1 Anterolateral Abdominal Wall & TAP Block (SOE)

On this cadaver and ultrasound image, identify the muscles of the anterolateral abdominal wall (excluding rectus abdominis) & describe the orientation of their fibres

- External oblique muscle (EO; fibres pass downwards & forwards, 'hands in pockets' orientation)
- Internal oblique muscle (IO; fibres pass upwards & forwards, perpendicular to EO)
- Transversus abdominis muscle (TA; fibres pass transversely forwards to meet in the midline)

Describe their origin and insertion on this cadaver

- External oblique:
  - Origin: lower eight ribs
  - Insertion: linea alba (via rectus sheath), pubic tubercle and anterior ½ of iliac crest (lower margin of EO aponeurosis between pubic tubercle and ASIS forms the inguinal ligament)
- Internal oblique:
  - Origin: thoracolumbar fascia (TFL), anterior 2/3 of iliac crest & lateral 2/3 of inguinal ligament
  - Insertion: costal margin, linea alba (via rectus sheath), pubic crest (pectineal line via the conjoint tendon)
- Transversus abdominis (TA):
  - Origin: costal margin, TFL, anterior 2/3 of iliac crest & lateral 1/3 inguinal ligament
  - Insertion: linea alba (via rectus sheath), pubic crest (pectineal line via the conjoint tendon)

In which plane does the main neurovascular bundle lies. What nerves are found here?

- Plane: deep to IO and superficial to TA (i.e. between the middle and inner layers of the anterolateral abdominal wall)
- Nerves:
  - Thoraco-abdominal nerves; T7 - 11
  - Subcostal nerve; T12
  - Iliohypogastric nerve and its collateral branch (ilioinguinal nerve); L1

For which types of surgery may a transversus abdominis plane (TAP) block be beneficial?

- Lower abdominal surgery (around umbilicus (T9/10) and below; open inguinal/umbilical hernia repair, open appendicectomy, lower midline laparotomy)
- Gynaecological/obstetric surgery (abdominal hysterectomy, caesarian section)
- Urology (e.g. prostatectomy, nephrectomy, renal transplant)

Describe how you would perform a TAP block

- Consent
- Stop before you block (confirm side & site if unilateral)
- SLIMRAG:
  - Sterile procedure (wash hands, sterile gloves, sterile dressing pack)
  - Light source/ultrasound
  - IV access
  - Monitoring (AAGBI minimum standard)
  - Resuscitation drugs/equipment available
  - Assistant (who is happy to assist with regional or general anaesthetic

  - General anaesthetic: ensure equipment/drugs available to convert if required
- Position the patient supine, exposed from costal margin to below the iliac crest
- Clean the field with 0.5% chlorhexidine and allow to dry
- High frequency linear array ultrasound probe with sterile cover and gel
- Place the probe in the midline, aligned transversely, then scan laterally/posteriorly to the midaxillary line (between the costal margin and iliac crest):
  - Off the midline is the oval appearance of the rectus abdominis muscle
  - At its lateral border (linear semilunaris) are the three muscles of the lateral wall (EO, IO & TA)
  - Moving further laterally, these muscles will be visible as three parallel layers
- In plane technique with 80-100 mm short bevel regional block needle (inserted anteriorly, directed postero-laterally)
- After negative aspiration, inject 20 ml local anaesthetic on one/both sides, confirming negative aspiration after every 5 ml injection
- Confirm local anaesthetic spread within the plane between IO and TA during injection

3.2 Interscalene Block (SOE)

On this cadaver, demonstrate the dermatomes of the upper limb

- (C4 - acromioclavicular joint/shoulder tip)
- C5 - lateral arm
- C6 - lateral forearm, thumb & index finger
- C7 - middle finger
- C8 - ring/little finer & medial forearm
- T1 - medial arm
- (T2 - axilla)

What peripheral nerves supply the shoulder joint and skin of the shoulder region? Describe the region they supply

- (Lateral) supraclavicular nerve (C3/4): skin over shoulder as far as clavicle (anteriorly), acromion (laterally) & spine of scapula (posteriorly)
- Suprascapular nerve (C5/6): acromioclavicular joint/capsule & shoulder joint
- Axillary nerve (C5/6): shoulder joint & 'regimental badge' area
- Musculocutaneous nerve (C5/6/7): shoulder joint (& lateral forearm)
- Lateral pectoral nerve (C5/6/7): variable innervation around anterior shoulder joint soft tissue

What regional anaesthesia technique may be performed to block these nerves and which areas of the upper limb may not be blocked with this technique?

- Interscalene brachial plexus block* is the most common technique (blocks proximal nerve roots of brachial plexus and distal cervical plexus - supraclavicular nerves)
- Areas missed:
  - Posterior shoulder (supraclavicular nerve: this area often must be augmented by local anaesthetic infiltration at the posterior post site for awake arthroscopic shoulder surgery
  - Ring/little finger, medial forearm/arm and axilla (C8-T2: inferior roots of brachial plexus are not as well visualised in the interscalene grove and therefore may be missed, often blockade here is not required)

Name structures A-F on this ultrasound image

A) Nerve roots (C5-7)
B) Scalenus anterior muscle
C) Vertebral artery
D) Sternocleidomastoid muscle
E) Scalenus medius muscle
F) Phrenic nerve

*A shoulder block has also been described:

- Separate axillary and suprascapular nerve blocks
- Avoids phrenic nerve block and therefore may be useful in patient with significant respiratory limitation

List the possible neurological complications of an interscalene block

- Cervical cord injury (by needle trauma/injection)
- Epidural/subarachnoid injection of local anaesthesia
- Phrenic nerve blockade (approaching 100% in high volume block, symptomatic in around 30%)
- Cervical sympathetic chain block (Horner's syndrome)
- Vagal nerve block/injury or recurrent laryngeal nerve block/injury
- Injury to nerve roots of brachial plexus

- There is some concern that, using an in-plane technique, the dorsal scapular nerve and long thoracic nerves can be damaged by direct needle trauma as they lie on scalenus medius
- Vascular trauma (vertebral artery): bleeding and intravascaular injection/toxicity/seizure