

Questions

Question 1: True/False

Which of the following statements about the knee joint are true?

- The common fibular nerve is exposed as it winds around the neck of the tibia and may be injured by a medial blow to the knee.
- A lateral blow to the knee may cause injury to the medial collateral ligament, the medial meniscus and the anterior cruciate ligament, also known as the 'terrible triad'.
- The patella usually dislocates medially.
- The knee joint is a complex as well as a compound synovial hinge joint.
- A disc herniation at L4–L5 that compresses the exiting spinal nerve may result in ipsilateral wasting of the extensors of the knee joint.

Question 2: MCQ

A 45-year-old publican comes to the emergency department with central crushing chest pain that suddenly began 90 minutes ago. An ECG indicates injury of the posterior aspects of the septum and left ventricle. Which of the following arteries is most likely occluded?

- Anterior interventricular artery
- Right marginal artery
- Left circumflex artery
- SA-nodal artery
- Right coronary artery

Question 3: SAQ (5 points)

Describe how knowledge of the anatomy of the facial nerve could help you localise the level of the lesion in a person with a drooped left face. What signs and symptoms other than weakness may help you localise the lesion?

Question 4: MCQ

Skin cancers are responsible for around one-third of all human malignancies, and basal cell carcinomas are the most common skin cancer. Which skin layer do basal cell carcinomas arise from (Figure 1.1)?

Question 5: MCQ

During a classic embryology experiment, ectodermal cells are taken from the ectoderm of an embryo. In a neutral medium, they develop into the epidermal layer of skin. This is an example which is best described by which of the following terms?

- Fate
- Specification
- Determination
- Differentiation
- Commitment

Question 6: EMQ

- Left gastroepiploic artery
- Right gastroepiploic artery
- Celiac trunk
- Left gastric artery

- Hepatic artery
- Inferior mesenteric artery
- Right gastric artery
- Superior mesenteric artery
- Gastroduodenal artery
- Splenic artery
- Pudendal artery

For each of the scenarios below, choose the most appropriate answer from the list above.

- Which artery is compressible during a laparotomy as it travels through the free border of the lesser omentum?
- A 26-year-old woman comes in with a history of nausea and vomiting and is admitted to the emergency department. She has had a surgical correction of her scoliosis 2 months ago. An urgent barium meal shows almost total obstruction of the third part of the duodenum. Which blood vessel has probably caused the obstruction?
- A 53-year-old accountant is admitted to the emergency department with severe epigastric pain and haematemesis. He is haemodynamically unstable and is rushed for laparotomy. The surgeon finds profuse bleeding from a perforated ulcer in the posterior wall of the first segment of the duodenum. Which artery is most probably injured?
- A 78-year-old woman comes to see you with a lump on her back end. On examination, you find a 1 cm irregular mass on the anterior wall of the anal canal. Biopsy reveals an adenocarcinoma. Which artery does the tumour receive its blood supply from?
- A 36-year-old publican comes to the emergency department after he vomited blood earlier this morning. He is

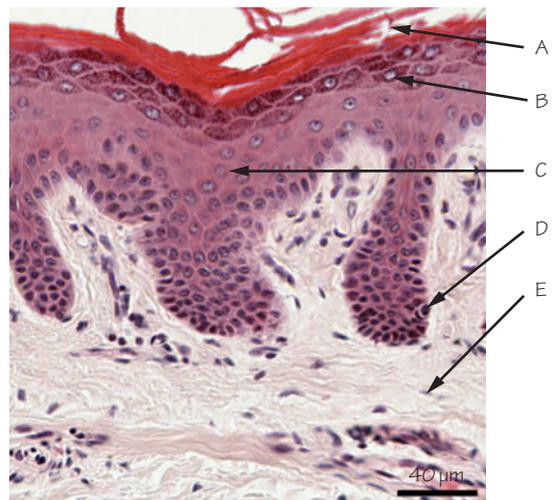


Figure 1.1 Skin layers. Reproduced with permission from Peckham M (2011) *Histology at a Glance*. Oxford: Wiley-Blackwell.

haemodynamically stable and an upper endoscopy confirms a Mallory–Weiss tear in the lower third of the oesophagus. From which artery's territory did the bleeding arise?

Question 7: SAQ (5 points)

A 40-year-old woman presents with shoulder pain. An investigation is carried out, and Figure 1.2 shows the image of her shoulder that is obtained.

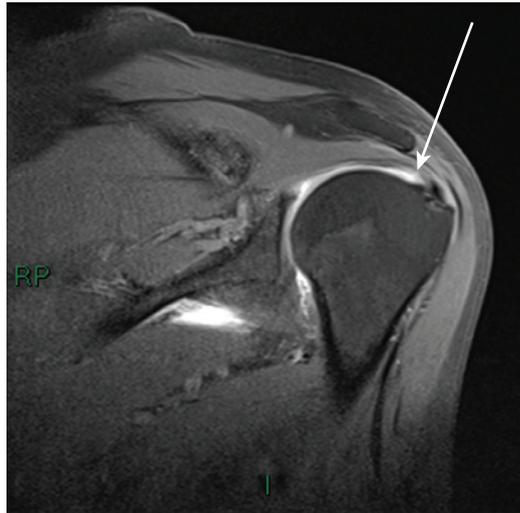


Figure 1.2 Image of the shoulder.

What imaging technique was used and what are its advantages and disadvantages? Which anatomical structure is affected by pathology (see arrow)?

Question 8: MCQ

A 56-year-old man presents with progressively worsening medial foot pain and walking difficulties. He is unable to plantarflex his great toe on the right, but able to plantarflex the remaining toes. What problem is underlying the pain and weakness?

- (a) Deep fibular neuropathy
- (b) Flexor hallucis longus tendinopathy
- (c) L5 spinal neuropathy
- (d) Tibial neuropathy
- (e) First metatarsal fracture

Question 9: MCQ

A 44-year-old man presents with a vesicular rash in the distribution of T3 on the right. He complains of burning pain, particularly on his back. What is the innervation of the back skin in that distribution?

- (a) Anterior ramus of T3
- (b) Anterior roots of T3
- (c) Posterior ramus of T3
- (d) Third intercostal nerve
- (e) Long thoracic nerve

Question 10: SAQ (5 points)

A 40-year-old man presents with severe loin pain that he cannot get comfortable with. He is suspected to have kidney stone disease in the ureters, and so he is given intravenous morphine and an investigation is arranged, the results of which are shown in Figure 1.3.



Figure 1.3 Results from investigation.

What is the name of this imaging technique and what are the two ways it can be obtained? On the image, mark the three spots where a kidney stone is most likely to lodge.

Question 11: True/False

A 7-year-old child comes in with a sore throat and difficulty breathing through his nose; he has a history of recurrent middle ear infections. These symptoms arise from enlargement of lymphatic tissue collectively known as Waldeyer's ring. Which of the following are parts of this ring protecting the respiratory tract?

- (a) Nasopharyngeal lymphatics
- (b) Submental lymphatics
- (c) Lingual lymphatics
- (d) Submandibular lymphatics
- (e) Tubular lymphatics

Question 12: EMQ

- A Ectoderm
- B Endoderm
- C Intermediate mesoderm
- D Neural crest
- E Mesenchyme
- F Somatic mesoderm
- G Somitic mesoderm
- H Splanchnic mesoderm
- I Yolk sac

For each of the scenarios choose the most appropriate answer from the list above.

- (1) A 55-year-old alcoholic presents with a dermatomal rash at the level of T4 on the right. It is very painful. What is the embryonic origin of the layer that provides pain sensation?
- (2) An infant with a known cardiac defect is diagnosed with CHARGE syndrome, which encompasses heart defects and craniofacial abnormalities including coloboma of the eye, choanal atresia, ear abnormalities and hearing loss. The infant also develops retarded growth and development and

has genital and urinary anomalies. The development of which of the above tissue groups has most probably been impaired?

- (3) A leukaemia researcher investigates the embryonic origin of lymphocytes. Apart from an initial extraembryonic origin of haematopoiesis, there is another group of haematopoietic stem cells, which arises from which intraembryonic tissue?
- (4) The enteric and autonomic nervous systems are derived from neural crest cells. Before being able to adopt their varied fates, neural crest cells will need to transform into what kind of tissue?
- (5) A child is born with congenital absence of the biceps. What is the embryonic origin of this muscle?

Question 13: MCQ

A 45-year-old man is found to have a new systolic murmur and is investigated with an echocardiogram (Figure 1.4). On examination and previous X-ray imaging, his heart is a normal size.

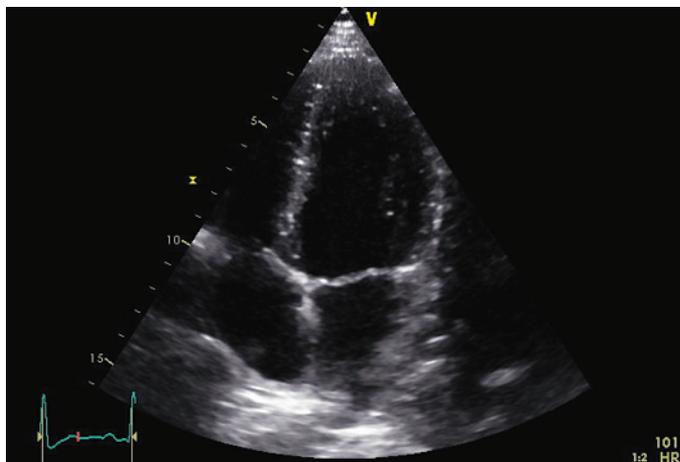


Figure 1.4 Echocardiogram showing a four-chamber view of the heart. Reproduced courtesy of Dr Richard Dobson.

Where does the ultrasound probe sit at this time point?

- (a) Fifth intercostal space, midaxillary line
- (b) Fifth intercostal space, midclavicular line
- (c) Second intercostal space, to the left of the sternum
- (d) Second intercostal space, to the right of the sternum
- (e) Xiphoid process

Question 14: MCQ

A man presents with weakness and pain in his hand and forearm. On examination, he has weakness of flexion of the index and middle fingers and the distal phalanx of the thumb, altered sensation over the thenar eminence and pain that worsens on pronation. The affected nerve runs through the two bellies of the most proximal muscle it supplies and has probably been compressed by this muscle. What is the name of this muscle?

- (a) Brachioradialis
- (b) Flexor carpi ulnaris
- (c) Flexor retinaculum of the biceps
- (d) Pronator teres
- (e) Supinator

Question 15: MCQ

A patient presents with haematuria and abdominal pain of 3 months duration. MRI scanning identifies a mass in the left kidney. He is scheduled for radical nephrectomy. Which of the following layers will allow the surgeon to easily separate the kidney without removing the adrenal gland?

- (a) Paranephric fat
- (b) Perinephric fat
- (c) Peritoneum
- (d) Renal (true) capsule
- (e) Renal (Grota's) fascia

Question 16: EMQ

Figure 1.5 shows a CT of the thorax. Please select the letters that match the descriptions below.



Figure 1.5 CT thorax.

- (1) The thoracic duct inserts into this structure.
- (2) This structure pierces the diaphragm at the level of T10.
- (3) This structure has a wall made of incomplete cartilaginous rings.
- (4) This structure is derived from the third branchial arch.
- (5) This structure terminates at the level of L1–L2.

Question 17: True/False

Which of the following statements about groin anatomy are true?

- (a) When examining for hernias, an indirect inguinal hernia will be found inferior and lateral to the pubic tubercle.
- (b) During surgery for inguinal hernias, the iliohypogastric nerve may be injured, resulting in anaesthesia or chronic pain in the groin.
- (c) Venepuncture of the femoral vein is achieved by inserting the needle medially to the midinguinal point.
- (d) The deep inguinal ring is found lateral to the inferior epigastric artery.
- (e) The internal spermatic fascia is continuous with the aponeurosis of the transversus abdominis.

Question 18: MCQ

A light microscopic image of bone (Figure 1.6) shows the following structure.

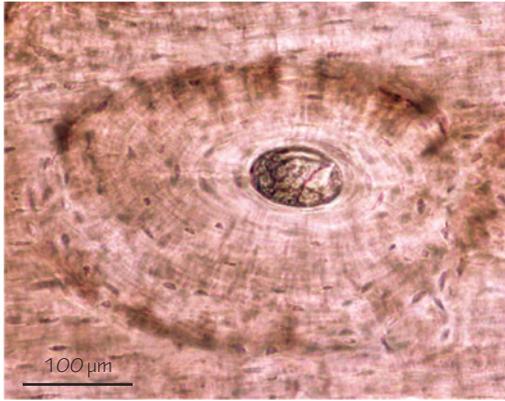


Figure 1.6 Light microscopic image of bone. Reproduced with permission from Peckham M (2011) *Histology at a Glance*. Oxford: Wiley-Blackwell

What type of bone does the section originate from?

- (a) Hyaline cartilage
- (b) Woven bone
- (c) Cancellous bone
- (d) Compact bone
- (e) Cancellous or compact bone

Question 19: MCQ

A 25-year-old man is diagnosed with CNS sarcoidosis and has multiple cranial nerve defects. The treating doctor decides to test the gag reflex. Which cranial nerve lesion will produce an absent gag reflex on the affected side?

- (a) IX only
- (b) IX and X
- (c) IX or X
- (d) V₃ and X
- (e) V₃ or X

Question 20: SAQ (5 points)

Describe the anatomy and clinical significance of the acetabulum.

Question 21: EMQ

- A Median nerve at the wrist
- B Median nerve at the elbow
- C Long thoracic nerve
- D C5 and C6
- E C8 and T1
- F Axillary nerve
- G Radial nerve below the elbow
- H Radial nerve above the elbow
- I Ulnar nerve at the elbow
- J Ulnar nerve at the wrist

For each scenario below, choose the nerve injury from the list above.

- (1) A 34-year-old woman with rheumatoid arthritis comes to see you because she has felt pain in her hand and has had difficulty writing. Examination reveals pain on the lateral surface of the palm and the lateral 3½ digits, as well as the

inability to maintain the middle finger and thumb opposed against resistance.

- (2) A 20-year-old university student presents to your clinic because he woke up today with a left 'floppy hand'. He also complains of a headache. He was fine until yesterday, when he went to a party, at which he fell asleep slumped in a chair. Examination reveals a young man smelling of alcohol without any bruises or cuts. In the left arm there is 2/5 weakness of both wrist and finger extension and 4/5 weakness of elbow extension. Sensory testing reveals reduced sensation on the medial side of the dorsum of the wrist.
- (3) You are asked to see a 71-year-old lady who has been in hospital following a cardiac valve operation, from which she has been recovering well. However, she noticed some tingling in her right hand today. On examination, you detect weakness of ad- and abduction of the fingers. In addition, she cannot flex the distal interphalangeal joints of the little and ring finger. On sensory testing, you find reduced sensation on the medial side of the right ring finger compared to its lateral side.
- (4) An elderly gentleman comes into your practice for a check-up. You notice that his left arm hangs flaccidly, internally rotated at the shoulder and extended at the elbow. His forearm is pronated. He explains that his left arm became paralysed following a motorcycle injury 20 years ago.
- (5) A 58-year-old woman comes for her follow-up visit 4 weeks after her breast surgery. She complains of not being able to comb her hair or store things on shelves or cupboards above her shoulder. Examination shows winging of the scapula when she pushes her hands against the wall.

Question 22: MCQ

An 85-year-old lady with known congestive cardiac failure presents with swallowing difficulty. She has a heart murmur and investigations show that a particular structure is enlarged and presses against the oesophagus. Enlargement of which structure will probably result in compression of the oesophagus?

- (a) Left ventricle
- (b) Left atrium
- (c) Left atrial appendage
- (d) Thymus
- (e) Right ventricle

Question 23: True/False

Which of the following statements about early embryology are true?

- (a) A 20-year-old man attends a fertility clinic and is found to have inverted organ positions and is diagnosed with Kartagener syndrome. This arises from a defect in left–right asymmetry, which is established at the primitive node by ciliary movements.
- (b) During implantation, the embryonic trophoblast induces the decidual reaction, which induces maternal tissue to form the syncytiotrophoblast, which acts as an immunological and physical barrier between the maternal and fetal circulations.
- (c) A woman undergoes amniocentesis after her triple test has returned with a high probability of Down syndrome. The amniotic cavity is formed during early development with splitting of the extraembryonic mesoderm into two layers.
- (d) After formation of the placenta, fetal tissues are in direct contact with maternal blood in humans.

- (e) With the formation of the trilaminar embryo through gastrulation in week 3, these three layers account for all embryonic tissues.

Question 24: MCQ

A 56-year-old golfer presents with intense pain on the palmar aspect of his hand that started when he was playing golf and accidentally hit the ground instead of the ball. He has not been able to straighten his medial two fingers since. On examination, his proximal palm is very tender and he has marked weakness of extension of the two medial metacarpophalangeal joints and he cannot ab- or adduct his fingers. An X-ray shows a fracture in one of the carpal bones.

- Capitate
- Hamate
- Scaphoid
- Trapezium
- Trapezoid

Question 25: MCQ

A 30-week pregnant woman comes to your office concerned that she is experiencing an incessant pulling sensation 'down below'. Examination localises the pulling to the labia majora. You reassure her that this is the result of a normal anatomical connection. What is the name of this connection?

- Suspensory ligament
- Broad ligament
- Processus vaginalis
- Transverse cervical (cardinal) ligament
- Round ligament

Question 26: EMQ

Figure 1.7 is a light micrograph of an epiphyseal growth plate.

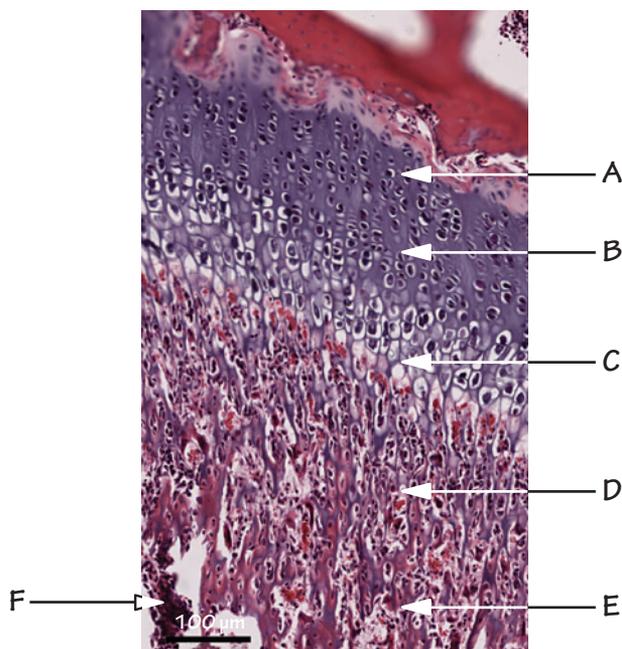


Figure 1.7 Light micrograph of an epiphyseal growth plate. Reproduced with permission from Peckham M (2011) *Histology at a Glance*. Oxford: Wiley-Blackwell.

- A runner prepares for a marathon and his muscle mass increases as he progresses through his training programme. Which area at the growth plate resembles this process?
- Neoplastic processes are characterised by multiple mitoses, but it is important to recognise that some areas will have increased mitosis in the absence of neoplasia. Which area of the normal epiphyseal plate is replicating fastest?
- Apoptosis is an important process that controls proliferation and tissue structure. Which area in the micrograph above is characterised by apoptosis?
- A patient with renal failure receives an injection of erythropoietin. Which area will this hormone act on?
- Where would you expect to see an osteoblastoma (tumours that arise from osteoblasts)?

Question 27: MCQ

A 17-year-old college student is brought in by ambulance unconscious. He was playing cricket without a helmet and was hit by the bat on the side of his head. A CT scan of his head shows a fracture at the junction of the parietal, occipital, frontal and sphenoid bones. Which cranial foramen does the most likely damaged structure pass through?

- Foramen spinosum
- Internal acoustic meatus
- Foramen ovale
- Foramen lacerum
- Superior orbital fissure

Question 28: SAQ (5 points)

Why is the diaphragm innervated by C3–5?

Question 29: MCQ

A 10-year-old obese child presents to the orthopaedic surgeons with knee pain and a detailed clinical examination reveals that the pain is referred to the knee from the hip. The child is diagnosed with a slipped femoral epiphysis. Which law describes the basis of referred pain to other joints?

- Bell–Magendie law
- Courvoisier's law
- Gerhardt's law
- Hilton's law
- Sherrington's law

Question 30: True/False

A 65-year-old woman with advanced breast cancer undergoes a CT of the head, chest, abdomen and pelvis to look for metastases. Which routes of spread are possible in breast cancer?

- Spread to thoracic vertebrae due to communications of the intercostal veins and the vertebral venous plexus.
- Spread to the liver via the portal vein.
- Spread to the brain via the vertebral venous plexus.
- Spread to the opposite breast through lymphatics crossing the midline.
- Spread to the ipsilateral supraclavicular lymph nodes is the most likely route of lymphatic spread.

Answers to Exam 1

Answer 1: True/False

See *Anatomy at a Glance, 3rd edn (The knee joint)*.

- (a) **False.** The common fibular nerve winds around the neck of the *fibula* and may be injured by a *lateral* blow below the knee as it is compressible against bone in that area. The common fibular nerve supplies the anterior and fibular muscle compartments of the thigh which are involved in dorsiflexion and eversion. Lack of dorsiflexion results in foot drop.
- (b) **True.** Concomitant damage to both the medial collateral ligament and the medial meniscus is common because they are strongly fixed to each other.
- (c) **False.** The most common direction of patellar dislocation is *laterally*. It occurs most frequently in teenagers as a result of sports injury. The quadriceps femoris pulls the patella laterally and superiorly. In healthy individuals the patella is held in place by the prominent lateral femoral condyle, a strong vastus medialis inserting medially as well as the patellofemoral ligament.
- (d) **True.** The knee is a synovial joint with the following properties. First, it is compound, i.e. three or more bones contribute articular surfaces. These are the femur, tibia and patella, but *not the fibula*. Second, the knee joint is complex – it has intra-articular cartilaginous menisci, helping to make the non-matching articular surfaces congruent (matching).
- (e) **False.** The extensors of the knee joint are the quadriceps femoris muscles. They are supplied by the femoral nerve which receives input from L2, L3 and L4. The nerve root exiting between the L4–L5 vertebrae is the L4 spinal nerve. However, as it exits above the compression, it is not the nerve root that is affected by disc compression at this level. An L4–L5 disc bulge instead ‘catches’ the L5 nerve root which is getting ready to exit in the L5–S1 vertebral foramen. Since L5 nerves do not contribute to femoral nerve innervation, no trophic changes occur in the anterior thigh.

Answer 2: MCQ

See *Anatomy at a Glance, 3rd edn (The heart II)*.

(e) The posterior myocardium is supplied by the posterior interventricular artery, which is a branch of the right coronary artery (e). The right marginal artery supplies part of the right ventricle. The SA nodal artery supplies the SA node and right atrium, and is supplied by the right coronary artery in 60% of humans and by the left circumflex in 40%. The left circumflex supplies part of the left ventricle and left atrium. The left interventricular artery, the other main branch of the left coronary, supplies the anterior part of the left and right ventricles (Figure 1.8).

Answer 3: SAQ

See *Anatomy at a Glance, 3rd edn (Cranial nerves VI–XII)*.

All lesions of the facial nerve result in facial droop on the ipsilateral side, but depending on the level of the injury, additional functions of the facial nerve may be affected. Thus a lesion of only the muscles of facial expression suggests a distal lesion within the parotid gland (1). A lesion at the stylomastoid foramen will additionally result in paralysis of the stylohyoid and the posterior belly of digastrics (2, impossible to assess clinically). A lesion in the facial canal will additionally result in decreased salivation and loss of taste on the anterior two-thirds of the tongue due to loss of the chorda tympani (3). It may also cause hyperacusis, hypersensitivity in hearing, due to loss of the nerve to stapedius, which exits just proximally to the chorda tympani (4). Finally, a lesion proximal to the geniculate ganglion will also cause loss of lacrimation on the affected side, as preganglionic parasympathetics branch off at the geniculate ganglion (5). Bonus: a lesion of the corticospinal tract will cause a motor deficit on the contralateral side but spare the forehead as that is innervated bilaterally by both motor cortices (6).

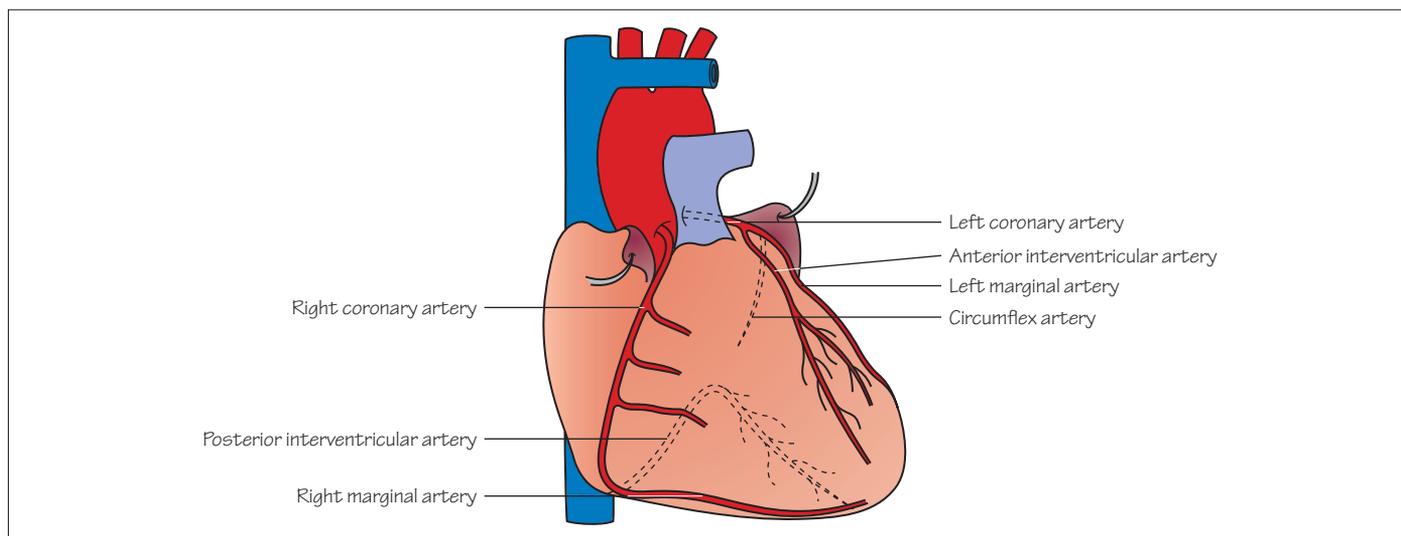


Figure 1.8 Coronary arteries. Reproduced with permission from Abrahams PH, Craven JL and Lumley JSP (2005) *Illustrated Clinical Anatomy*. London: Hodder Arnold.

Answer 4: to Exam 1 MCQ

(d) The strata of skin from outside to inside are stratum corneum (a), stratum lucidum, stratum granulosum (b), stratum spinosum (c), stratum basale (d) and the dermis (e). The stratum basale is a single layer of basophilic cells on the basement membrane that are stem cells for keratinocytes. Basal cell carcinomas arise from this layer, whereas squamous cell carcinomas arise from the stratum spinosum.

Answer 5: MCQ

(b) Cells are specified if they develop according to their normal fate in an isolated and neutral culture. This is in contrast to determination (c) which describes a tissue that will attain its normal fate even when placed in a non-neutral environment, which can induce the development of other structures. Both of these are two distinct steps in the commitment (e) of cells to their fate. Fate (a) describes the final product of the process of cell differentiation, which is an umbrella term that describes the process by which a less specialised cell becomes a more specialised cell (d). These concepts were most important when classic embryology experiments were the only ones to give us insight into embryology. Since the discovery of morphogens and hox genes and their role in cell differentiation, the importance of these concepts has declined.

Answer 6: EMQ

See *Anatomy at a Glance*, 3rd edn (The arteries of the abdomen).

- (1) E. The free border of the lesser omentum contains the portal triad: the hepatic artery, common bile duct and the portal vein, and forms the anterior border of the epiploic foramen (of Winslow). If the cystic artery continues bleeding after a cholecystectomy, haemostasis can be achieved by compressing the hepatic artery within the free border of the lesser omentum between two fingers.
- (2) H. The third part of the duodenum is related anteriorly to the superior mesenteric artery and posteriorly to the aorta. In rare circumstances the duodenum can be compressed between the two vessels, causing obstruction. This is known as the SMA syndrome. Predisposing factors include surgery for scoliosis and drastic weight loss leading to loss of the fat pad at the origin of the SMA that normally keeps the two blood vessels apart.
- (3) I. The gastroduodenal artery and the common bile duct form the posterior relations of the first part of the duodenum and are at risk of injury if an ulcer in this area perforates.
- (4) F. The anus is a watershed region that is supplied superiorly by the superior rectal artery arising from the inferior mesenteric artery, and inferiorly by the middle and inferior rectal arteries from the pudendal artery. The different blood supply reflects the different embryonic origin of the two parts of the anus: the superior part of the anus arises from endoderm and is lined by columnar epithelium, like the rest of the digestive tract, whereas the inferior part of the anus arises from ectodermal tissue and thus is lined by stratified squamous epithelium.
- (5) D. The three thirds of the oesophagus are supplied by three different arteries. The inferior third, relevant to this clinical vignette, is supplied by the oesophageal branch of the left gastric artery. The middle third is supplied by oesophageal branches directly arising from the aorta and the upper third is supplied by the inferior thyroid arteries.

Answer 7: SAQ

See *Anatomy at a Glance*, 3rd edn (The axilla).

The image above is obtained by magnetic resonance imaging (it is a T2-weighted image). It shows pathology in the supraspinatus muscle and tendon. Advantages include high resolution in soft tissue and thus high sensitivity, no contrast needed and no exposure to ionising radiation. Disadvantages include that MRI is expensive/resource-intensive and cannot be done if the patient has a pacemaker, is very obese or claustrophobic.

Answer 8: MCQ

See *Anatomy at a Glance*, 3rd edn (The nerves of the lower limb II; and The ankle and foot II).

(b) The problem described here most likely relates to a mechanical rather than neurological problem that is giving rise to flexor hallucis longus dysfunction. The L5 spinal nerve particularly supplies the *extensor hallucis longus* (c), and damage to the deep fibular nerve results in inability to extend toes and variable foot drop (a). Tibial neuropathies on the other hand result in decreased sensation in the sole of the foot, and weakness in ankle and toe plantarflexion, depending on the level of the injury (d). Fractures may cause pain and limited movement, but this will not be direction specific and the patient would be unlikely to bear weight (e).

Answer 9: MCQ

(c) The skin over the back is innervated by a cutaneous branch of the posterior ramus of T3, which is not a named nerve. Both the anterior and posterior ramus arise from the mixed spinal nerve of T3. The anterior ramus gives rise predominantly to the third intercostal nerve which has lateral and terminal cutaneous branches that supply the skin overlying the lateral and anterior chest wall.

Answer 10: SAQ

Figure 1.9 shows a urogram, which is obtained by delivering contrast to the ureters and bladder and taking an X-ray (1). It can be



Figure 1.9 Urogram. Black dots denote the places where a kidney stone is most likely to lodge: the ureteropelvic junction, the pelvic brim and the ureteric orifice.

obtained in two ways: in an IV urogram the contrast is administered intravenously, and in a retrograde urogram it is administered using a cystoscope through the urethra (2). The three relatively narrowest regions in a ureter are the ureteropelvic junction (3), the pelvic brim (4) and the ureteric orifice (5). This investigation is no longer routinely performed today as it has been surpassed by spiral CT imaging.

Answer 11: True/False

See *Anatomy at a Glance, 3rd edn (The mouth, palate and nose)*.

Waldeyer's ring is formed by mucosa-associated lymphoid tissue (MALT), and forms the initial defence against pathogens entering the respiratory and gastric tracts through the nose and mouth. Its constituents are known as tonsils because, unlike lymph nodes, they are incompletely encapsulated. Waldeyer's ring consists of the nasopharyngeal tonsil (a, 'adenoids'), the paired tubular tonsils (e), the paired palatine tonsils ('the tonsils') and the lingual tonsil (c).

- (a) **True.** The 'adenoids' or the nasopharyngeal tonsil is an area of lymphatics found on the posterior surface of the nasopharynx which may increase to obstruct the nasopharyngeal passageway in children, resulting in sleep apnoea.
- (b) **False.** The submental lymph nodes can be felt in the anterior triangle of the neck and drain the tongue, lower lip and floor of the mouth. They do not belong to Waldeyer's ring of tonsils.
- (c) **True.** Can be found on the posterior aspect of the tongue and are the most inferior of lymph glands forming Waldeyer's ring.
- (d) **False.** The submandibular lymph nodes can be felt in the posterior floor of the mouth and are related to the submandibular salivary gland. They drain the upper lip, cheek and parts of the lower lip, gums and tongue.
- (e) **True.** The tubular lymphatics surround the pharyngeal entrance to the eustachian tube, and may play a role in recurrent middle ear infections. Due to the blockage of the eustachian tubes, a negative pressure results in the middle ear, triggering a serous effusion that can provide a breeding ground for middle ear infections.

Answer 12: EMQ

See *Anatomy at a Glance, 3rd edn (Embryology)*.

- (1) **F.** Sensation, including pain sensation, is a function of the dermis, which arises from somatic mesoderm. Somatic mesoderm is formed when the coelom divides the lateral plate mesoderm into two parts. Somatic mesoderm is the dorsal part and forms the body wall lining.
- (2) **D.** The combination of craniofacial abnormalities together with cardiac abnormalities is most consistent with a neural crestopathy, which CHARGE syndrome is believed to be. No other embryonic tissue gives rise to such a varied group of tissues.
- (3) **H.** The first wave of haematopoiesis occurs in the extraembryonic splanchnic mesoderm of the yolk sac and gives rise to the myeloid lineage that includes erythrocytes and neutrophils. However, there appears to be a second intraembryonic source of haematopoietic stem cells, which arises from splanchnic mesoderm, specifically from the aortic, gonad and mesonephros (AGM) region. These cells arise

independently from yolk sac progenitors and both waves of haematopoietic stem cells are needed for the creation of definitive stem cells.

- (4) **E.** Neural crest cells are derived from ectoderm – this does not change throughout development. However, initially they are epithelial and epithelial-to-mesenchymal transformation is a key step in the differentiation of neural crest cells. It is important to realise the difference between mesenchyme and mesoderm to answer this question: mesenchyme describes undifferentiated loose connective tissue that is non-epithelial, and does not relate to germ layer origins. Most mesenchyme is mesodermal, but some is ectodermal (neural crest cells).
- (5) **G.** Muscles of the axial and appendicular skeleton arise from somitic mesoderm, more specifically from the dermomyotome of somites. It is important not to confuse somitic with somatic mesoderm, which is found in the lateral plate of the embryo.

Answer 13: MCQ

See *Anatomy at a Glance, 3rd edn (Surface anatomy of the thorax)*.

- (b) This is an echocardiogram of the heart that shows all four chambers. The probe always sits at the meeting point of the two straight edges, which is the top in this case. All four chambers and the two atrioventricular valves can only be visualised from the apex of the heart on the transthoracic echo. The apex in a healthy individual with a normal heart size lies at the fifth intercostal space, midclavicular line.

Answer 14: MCQ

See *Anatomy at a Glance, 3rd edn (Nerves of the upper limb I and II)*.

- (d) The median nerve supplies most of the muscles in the flexor compartment of the forearm as well as the thenar compartment of the hand, the medial two lumbricals and the skin overlying the thenar compartment. Just below the elbow, the nerve passes between the two bellies of pronator teres, before it gives off the anterior interosseous nerve that supplies the deep muscles of the forearm including flexor pollicis longus and the medial half of flexor digitorum profundus. In pronator teres syndrome, compression of the nerve by pronator teres affects the anterior interosseous nerve and the median nerve below the wrist, as is the case in this patient.

Answer 15: MCQ

See *Anatomy at a Glance, 3rd edn (The posterior abdominal wall)*.

- (e) The kidneys and adrenal glands lie within a fatty layer within the retroperitoneal space. The kidney is enclosed by a true fibrous capsule (d), which lies in a fatty layer (b) that is contained within the renal fascia (e). The renal fascia is continuous with the transversalis fascia and encloses the suprarenal glands separately and thus creates a plane which allows easy separation of these two organs. Finally the paranephric fat can be found on the outside of the renal fascia (a).

Answer 16: EMQ

See *Anatomy at a Glance, 3rd edn (The lungs; The thoracic wall II; and The mediastinum I and II)*.

This is a classic transverse section through the thorax that needs to be recognised. It is at the level of the T3 vertebra, just above the aortic arch, showing the three arteries that supply the upper limbs and the head and neck.

- (1) E. The thoracic duct inserts into the origin of the left brachiocephalic vein.
- (2) F. The oesophagus pierces the diaphragm at the level of T10 through an opening in the right crus together with the vagus nerves and the azygos vein.
- (3) A. The trachea is often described as 'D-shaped' on transverse sections. It acquires this shape from the incomplete cartilaginous rings in its wall, which are open posteriorly.
- (4) C. The left common carotid artery can be felt as the 'carotid pulse' in the neck. It is derived on both sides from the third branchial arch. The brachiocephalic trunk (D) and both subclavian arteries (B and continuation of D) are derived from the IV branchial arch.
- (5) H. The spinal cord terminates at the conus terminalis at the level of L1–L2.

Answer 17: True/False

See *Anatomy at a Glance*, 3rd edn (The abdominal wall; and Surface anatomy of the abdomen).

- (a) **False.** An indirect inguinal hernia enters the inguinal canal through a patent processus vaginalis which continues through the inguinal canal. By convention, it always arises above the inguinal ligament. If large, it may emerge through the superficial ring, and then it can be felt superior and medial to the pubic tubercle, and may then also enter the scrotum. This is to distinguish it from a femoral hernia, which can be found inferior and lateral to the pubic tubercle.
- (b) **False.** The iliohypogastric nerve (L1) does not enter the inguinal canal. It supplies the area superior to the groin. The *ilioinguinal nerve* travels through the inguinal canal where it is susceptible to damage. Unlike all other structures traversing the inguinal ligament, it travels just on the spermatic cord and not within it. It does not descend into the scrotum with the spermatic cord, but separates from the cord at the superficial ring to supply the skin over the anterior scrotum and the root of the penis (or the anterior labia in the female).
- (c) **True.** The midinguinal point can be found midway between the pubic *symphysis* and the anterior superior iliac spine. It is the site of the femoral artery. The midinguinal point should not be confused with the midpoint of the inguinal ligament (see d). The needle should be inserted medial to the arterial pulsation. Laterally lies the femoral nerve, which should be avoided. A useful mnemonic is NAVY, the letters stand for nerve, artery, vein and Y-trunks (an *aide-mémoire* for the midline).
- (d) **True.** The deep inguinal ring can be found at the midpoint of the inguinal ligament, halfway between the pubic *tubercle* and the anterior superior iliac spine. The inferior epigastric artery passes just medial to the deep inguinal ring. During surgery, it is possible to distinguish indirect hernias, which enter the inguinal canal lateral to the artery through the deep ring, from direct hernias which enter the inguinal canal medially through a defect in Hesselbach's triangle.
- (e) **False.** Transversus abdominis arches over the inguinal canal but does not contribute a fascial layer to the spermatic cord, unlike external oblique, which forms the external spermatic fascia, and internal oblique, which forms the cremasteric fascia. The internal spermatic fascia arises from the transversalis fascia.

Answer 18: MCQ

(e) The section shows an osteon, formerly known as a haversian system. It is the hallmark of secondary (lamellar) bone and the building block of cancellous as well as compact bone. It consists of concentrically arranged lamellae that are arranged around a hollow central canal which contains nerve artery and vein.

Answer 19: MCQ

See *Anatomy at a Glance*, 3rd edn (Spinal nerves and cranial nerves I–IV).

(c) The gag reflex has an afferent and an efferent limb. The afferents of the posterior tongue and pharynx are carried by the glossopharyngeal nerve, whereas the efferent limb is carried by the vagus nerve. Failure of either the afferent or the efferent limb will result in suppression of the pharyngeal reflex.

Answer 20: SAQ

See *Anatomy at a Glance*, 3rd edn (The hip joint and gluteal region).

The acetabulum is the fossa on the lateral aspect of the hip bone that articulates with the femur to form the hip joint, a ball and socket joint (1). The cupped shape of the acetabulum gives the hip joint both stability and weight-carrying capacity, at the same time allowing for a large degree of movement (2). The ilium, ischium and pubis all contribute to the acetabulum (3). The acetabulum is reinforced by the acetabular labrum (4).

The acetabulum is deficient inferiorly, at the acetabular notch (5). From the acetabular notch (and the fossa superior to it) arises the ligamentum teres. Within it passes an artery that supplies the head of the femur in children, but regresses after the fusion of the femoral epiphysis (6).

Answer 21: EMQ

See *Anatomy at a Glance*, 3rd edn (Nerves of the upper limb I and II).

- (1) A. Median nerve injury at the wrist, known as carpal tunnel syndrome, is a common injury and rheumatoid arthritis is an important predisposing factor.
- (2) H. This is a classic example of 'Saturday night palsy'. The radial nerve supplies the triceps and the wrist and finger extensors. It also supplies the posterior aspects of the forearm and the lateral dorsal aspect of the wrist and the lateral 3½ digits. Sensory loss is variable and complete anaesthesia is rare due to considerable overlap with the other major nerves supplying the upper extremity. Usually only a small area over the first dorsal interosseous muscle between thumb and index finger on the posterior aspect of the hand is affected.
- (3) J. Paralysis of the ulnar nerve at the elbow is common, as it is exposed behind the medial epicondyle, colloquially known as the 'funny bone'. Ulnar nerve damage at the wrist and elbow predominantly leads to paralysis of most small muscles of the hand other than those supplied by the median nerve. If long standing (not in this case), it results in the characteristic appearance of ulnar nerve injury known as 'claw hand'; the paralysis of the interossei and medial lumbricals leads to an unopposed action of the long digital flexors and extensors, resulting in hyperextension of the metacarpophalangeal joints and flexion of the interphalangeal joints. The difference between ulnar nerve injury at the wrist and elbow is subtle: inability to flex the two medial distal interphalangeal joints

and radial deviation on wrist flexion are seen in lesions at the elbow in addition to those seen at the wrist. A lower trunk brachial plexus injury may also produce a paralysis of the small muscles of the hand, but will not present with the characteristic pattern of ulnar sensory loss.

- (4) **D.** Injury of the upper roots of the brachial plexus is also known as Erb–Duchenne paralysis. Muscles supplied by C5 and C6 are paralysed and include supraspinatus, deltoid, biceps and brachialis, resulting in lack of shoulder movement and elbow extension. The forearm is pronated due to paralysis of the biceps, which is the main supinator. This appearance is the classic ‘waiter’s tip position’.
- (5) **C.** The long thoracic nerve supplies serratus anterior, which travels on the surface of the muscle in the midaxillary line where it is prone to injury during knife fights or breast surgery. Its function is to keep the scapula close to the thoracic wall. Together with trapezius, it also rotates the scapula to allow abduction of the shoulder of more than 90°.

Answer 22: MCQ

See *Anatomy at a Glance*, 3rd edn (The mediastinum I).

(b) Of the above structures, only the left atrium is a direct relation of the oesophagus. The left ventricle forms the left border of the heart, while the right ventricle is situated anteriorly. The left atrial appendage again lies on the left surface of the heart and is too small to cause significant obstruction. Finally, the thymus is found in the anterior mediastinum. The heart lies between it and the oesophagus.

Answer 23: True/False

See *Anatomy at a Glance*, 3rd edn (Embryology).

- (1) **True.** Left–right asymmetry is established early in embryology at the primitive node. Extracellular dynein molecules play a role in the establishment of this asymmetry, possibly by the creation of unidirectional flow of a morphogen. Kartagener syndrome involves an abnormality in a gene coding for dynein.
- (2) **False.** The syncytiotrophoblast arises from the proliferation of the cytotrophoblast. The decidual reaction is a response by maternal endometrial stroma that is induced by the implanting blastocysts; it results in the accumulation of lipids and glycogen.
- (3) **False.** The amniotic cavity arises during the formation of the bilaminar embryonic disc. A little fluid-filled cavity arises between the cells of the inner cell mass, and this develops into the amniotic cavity. Soon thereafter, another fluid-filled layer develops between the extraembryonic mesoderm of the trophoblast, which is the chorionic cavity. Although the chorionic cavity is larger initially, the amniotic cavity soon outgrows it and it is amniotic fluid that is sampled at amniocentesis.
- (4) **True.** The human placenta is haemochorial; that is, the chorion/trophoblast directly comes into contact with maternal blood. This is in contrast to the endotheliochorial placenta seen in cats and dogs, where endothelium directly apposes the trophoblastic tissue. In cows, pigs and horses even the maternal endometrial epithelium remains intact, resulting in an epitheliochorial placenta which has three layers separating the maternal and fetal circulation.
- (5) **False.** This is almost true, but important exceptions to this rule are the primordial germ cells, which migrate to their final location from the yolk sac.

Answer 24: MCQ

See *Anatomy at a Glance*, 3rd edn (Nerves of the upper limb II).

(b) The clinical vignette provides a history of ulnar nerve damage at the level of the wrist: claw hand and weakness of the small muscles of the hand. Sensation on the dorsal 1½ fingers is spared because the dorsal branch of the ulnar nerve arises 5 cm above the wrist and takes a different course. The majority of the ulnar nerve, however, passes medial to the hook of hamate through Guyon’s canal, where it is prone to injury during hook of hamate fractures. Hook of hamate fracture is not uncommon in golfers.

Answer 25: MCQ

See *Anatomy at a Glance*, 3rd edn (The pelvis II).

(e) The round ligament, which is the lower part of the ovarian gubernaculum, connects the uterus and labia majora and traverses the inguinal canal in the female and may become taut in pregnancy.

The processus vaginalis (c) is an obliterated outpouching of the peritoneum into the inguinal canal, which follows the testes in the male and does not exist in the female. The transverse cervical ligaments (d) are fibromuscular condensations of the pelvic fascia that connect the upper part of the vagina and the cervix to the lateral pelvic walls. The broad ligament (b) is a double layer of peritoneum as it folds over the uterine tubes. It does not connect the uterus with the labia. The suspensory ligament (a) of the ovary is part of the broad ligament. It is a reflection of parietal peritoneum over the ovarian vessels which join the ovaries as they descend from the posterolateral abdominal wall.

Answer 26: EMQ

- (1) **C.** Muscles undergo hypertrophy during exercise; that is, they enlarge in size rather than number. A similar process occurs at the zone of hypertrophy at the epiphyseal growth plate.
- (2) **B.** The zone of proliferation will contain multiple mitoses amongst chondrocytes, and it is important to remember that this is a normal phenomenon.
- (3) **D.** The zone of calcified cartilage is characterised by the absence of chondrocytes but persistence of their calcified matrix in preparation for invasion by osteocytes.
- (4) **F.** The dark nuclei signify an area of bone marrow, which will contain areas of white blood cell proliferation and differentiation (basophilic, blue on H&E) and red blood cell synthesis (eosinophilic areas, red on H&E). Erythropoietin is a hormone that stimulates red cell differentiation.
- (5) **E.** Osteoblasts invade the osteogenic zone that has been abandoned by chondrocytes. They are found in the osteogenic zone and in mature bone only.

Answer 27: MCQ

See *Anatomy at a Glance*, 3rd edn (The arteries I).

(a) The meeting point of the parietal, occipital, frontal and sphenoid bones is also known as the *pterion*. The pterion is a weak point of the skull and is not uncommonly fractured during boxing, golf or bat games. This may damage the *middle meningeal artery*, which runs on the inside of the skull beneath the pterion, resulting in extradural haemorrhage and brain compression. The middle meningeal artery passes through the foramen spinosum together with the less significant meningeal branch of the mandibular division of the trigeminal nerve.

Answer 28: SAQ

See *Anatomy at a Glance*, 3rd edn (The thoracic wall II).

The diaphragm originates, at least in part, from the septum transversum (1). After craniocaudal folding, the septum transversum is located adjacent to somites C3–5 (2) and is innervated by them (3). While the septum remains relatively stationary, the dorsal embryo grows, which results in an *apparent* descent of the septum to T8–10 (4), pulling with it the phrenic nerve (5).

Answer 29: MCQ

See *Anatomy at a Glance*, 3rd edn (The nerves of the lower limb I).

(c) Hilton's law is the one eponymous law in anatomy that should be known to every doctor as it has great clinical and medico-legal significance. It states that the nerve supply of a joint is the same as the supply of the muscles acting on it. From this, it directly follows that if a muscle crosses two joints (e.g. sartorius crossing both hip and knee joints), one nerve may innervate more than one joint and thus pain may be referred. It is therefore important to always examine the joint below and above the one that is the source of the patient's problems.

Answer 30: True/False

See *Anatomy at a Glance*, 3rd edn (The venous and lymphatic drainage of the upper limb and the breast).

Breast cancer is well known for local and distant metastases that can arise years after apparently successful surgery and chemotherapy.

- (a) **True.** Metastasis of breast cancer to bone, and especially to thoracic vertebrae, is common due to the direct connection between the intercostal veins draining the breast and the internal vertebral plexus also known as Batson's plexus. In 1940 Batson found that dye injected into the breast of female specimens could be recovered in the vertebral veins.
- (b) **False.** Breast cancer may well spread to the liver. However, there is no part of the breast that empties directly into the portal system. Rather, cancer cells travel to the heart and from there to the digestive system to reach the liver.
- (c) **True.** Metastasis to the brain via the vertebral plexus is possible anatomically, as the internal vertebral plexus communicates with the occipital sinus superiorly as well as with the intercostal veins that drain the breast. However, arterial metastasis is far more likely and common in the case of breast cancer.
- (d) **True.** Metastasis to the opposite breast or opposite axillary lymph nodes is possible due to the overlapping lymphatic drainage of the medial breast.
- (e) **False.** Most lymph (80%) from the breast drains into the axilla via the pectoral nodes, though some drainage into the supraclavicular nodes may occur too. Axillary clearance is an effective way of reducing breast cancer recurrence.