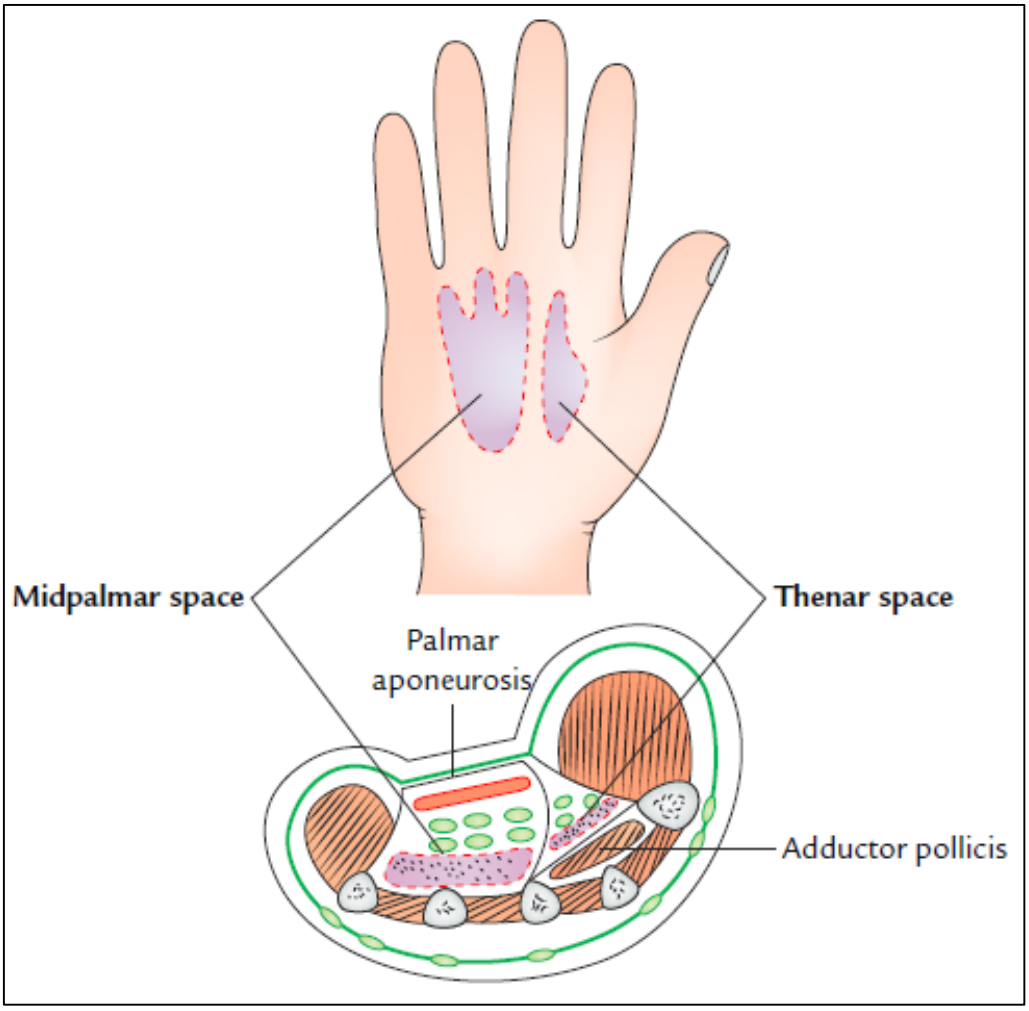


Figure 53: The thenar & midpalmar spaces.

The synovial (tendon) sheaths of the long flexors [Figure.54]

These sheaths surround the tendons of the long flexors; flexor digitorum superficialis, flexor digitorum profundus and flexor pollicis longus; starting a fingerbreadth (2-3 cm) proximal to the flexor retinaculum and ending distally at variable points. The synovial sheaths of the long flexors are arranged in 3 groups;

- The **radial bursa**; is the synovial sheath that surrounds the flexor pollicis longus tendon extending to the point of insertion of flexor pollicis longus (i.e. the distal phalanx of the thumb).
- The **ulnar bursa**; is the common synovial sheath for the eight tendons of flexor digitorum superficialis and flexor digitorum profundus. It starts 2-3 cm proximal to the flexor retinaculum and continues only with the tendons of the little finger to the level of the distal phalanx. For the middle 3 fingers it ends at the level of the proximal transverse crease of the palm and the tendons become exposed for a short distance; to give origin for the lumbricals; before entering the individual digital sheaths.

- The **digital synovial sheaths**; are 3 sheaths which surround the long flexor tendons of the index, middle and ring fingers. Each sheath begins just distal to the level of the distal palmar crease and ends at the base of the distal phalanx.

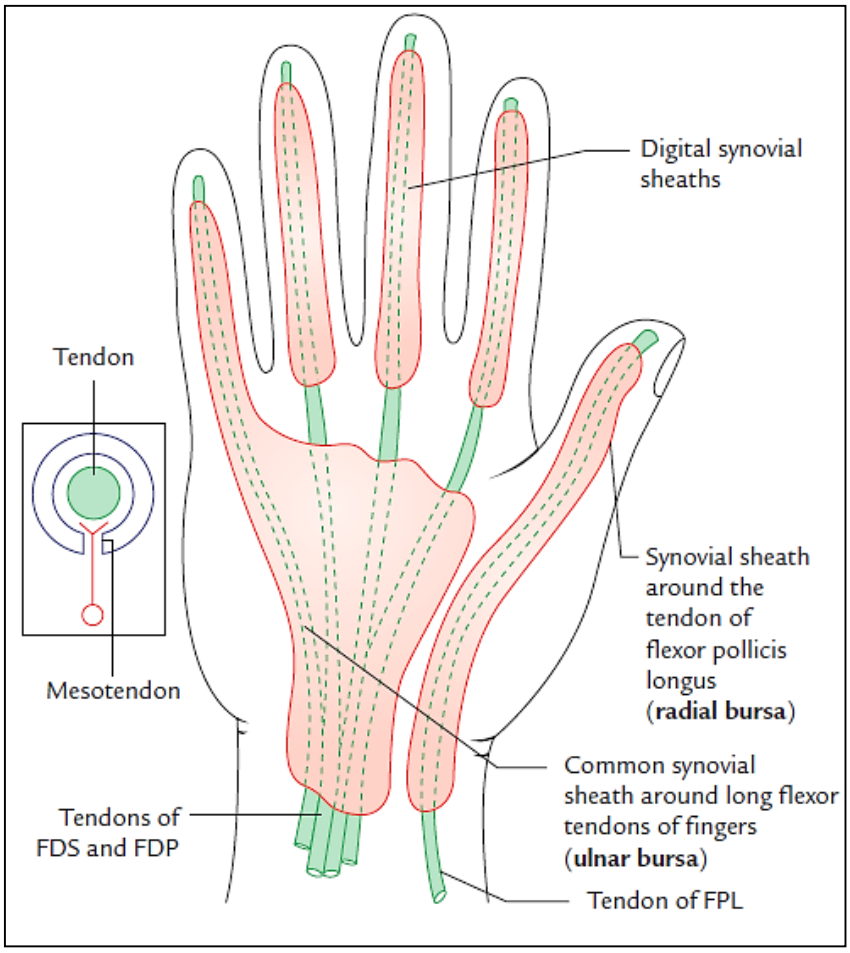


Figure 54: The synovial sheaths of the left hand.

The fibrous flexor sheaths and arrangement of the long flexor tendons at the fingers

The **fibrous flexor sheaths [Figure.55]** are thickened tunnels of deep fascia which lie on the anterior surface of each finger extending from the head of the corresponding metacarpal bone to the base of the distal phalanx and attach to the sides of the phalanges. The proximal end of each sheath is open while the distal end is closed. Thus, together with the phalanges and interphalangeal joints they form blind tunnels housing the tendons of the long flexors. They are strong over the phalanges but lax over the interphalangeal joints. Their function is to prevent the long flexor tendons from springing away from the digits during flexion of the fingers.

In the medial 4 fingers, there is a special arrangement of the tendons of flexor digitorum superficialis and flexor digitorum profundus at their insertion. Because flexor digitorum profundus is deeper and has a more distal insertion than flexor digitorum superficialis, each tendon of flexor digitorum superficialis flattens and splits into 2 bands at the base of the

proximal phalanx. These 2 bands embrace the tendon of flexor digitorum profundus allowing its passage towards the distal phalanx and then they reunite into one band which splits again to be inserted to the sides of the middle phalanx. The split bands of flexor digitorum superficialis tendon with the tendon of flexor digitorum profundus passing between them is known as the **chiasma tendinum**.

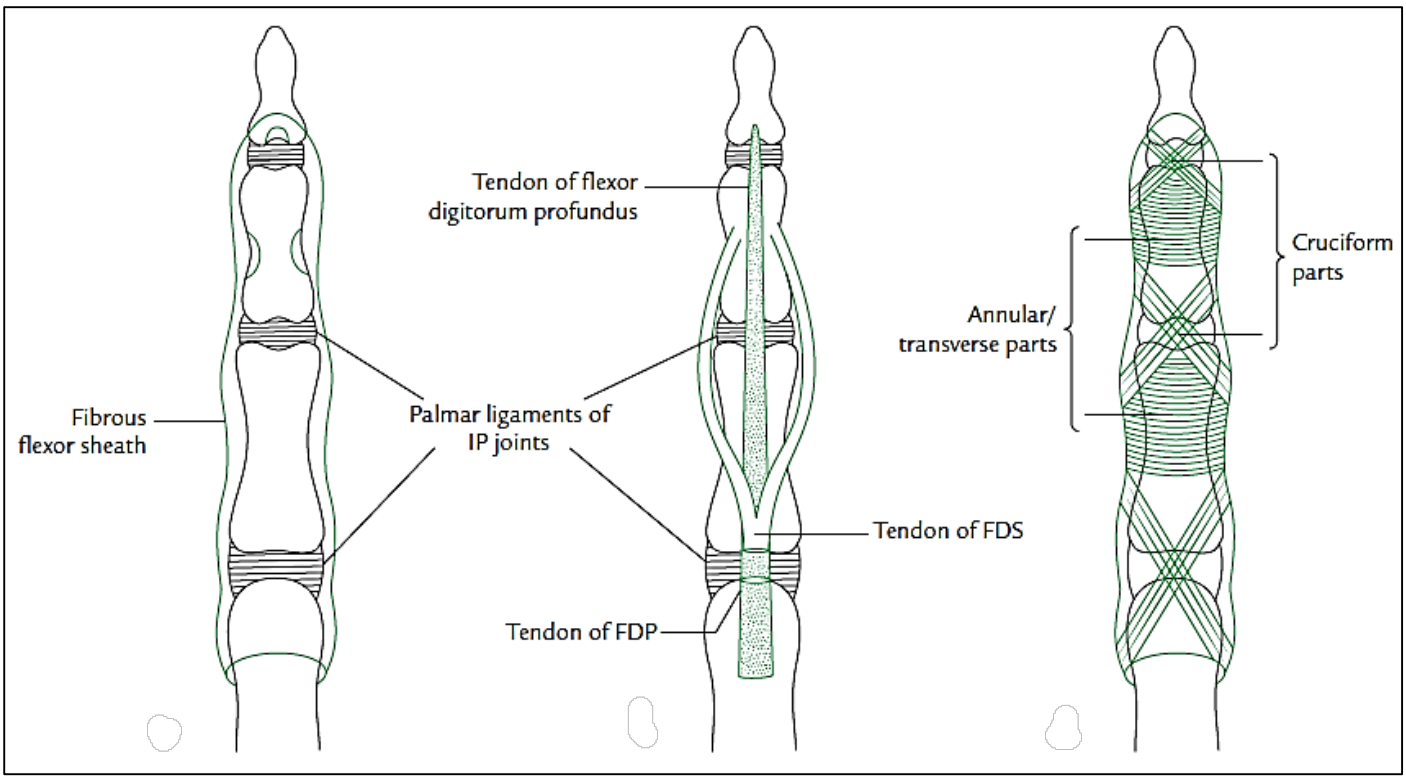


Figure 55: The flexor fibrous sheath and chiasma tendinum.

Intrinsic muscles of the hand

The small or intrinsic muscles of the hand may be divided into 5 groups;

- **Palmaris brevis muscle** (if present): lies in the superficial fascia over the hypothenar eminence. It helps to tens the palmar aponeurosis. It is supplied by the superficial branch of the ulnar nerve.
- **The palmar and dorsal interossei** arise lie between the metacarpal shafts. The palmar interossei adduct the fingers while the dorsal ones abduct the fingers.
- **The lumbrical muscles** are four muscle that arise from the tendons of the flexor digitorum profundus muscle. The lateral two are supplied by the median nerve while the medial two are supplied by the ulnar nerve. They act with the interossei to flex the metacarpophalangeal joints and extend the interphalangeal joints at the same time.
- **The thenar muscles**; are the short muscles of the thumb which include flexor pollicis brevis, abductor pollicis brevis, adductor pollicis and opponens pollicis. Their actions

are indicated by their names. All these muscles are supplied by the median nerve except adductor pollicis which is supplied by the deep branch of the ulnar nerve.

- **The hypothenar muscles**; are the short muscles of the little finger which include flexor digiti minimi, abductor digiti minimi and opponens digiti minimi. Their actions are indicated by their names. They are all supplied by the deep branch of the ulnar nerve.

In the lab: Distinguishing the intrinsic muscles of the hand [Figure.56, 57]

- The thenar muscles are arranged as two superficial & two deep. The superficial two are abductor pollicis brevis laterally & flexor pollicis brevis medially. The two deep ones are opponens pollicis laterally & adductor pollicis medially. Adductor pollicis has a large triangular head.
- The hypothenar muscle are arranged as one superficial (flexor digiti minimi) and two deep. The deep ones are abductor digiti minimi medially & opponens digiti minimi laterally.
- The lumbricals arise from the tendons of flexor digitorum profundus.
- The palmar interossei insert to the lateral 2 & medial 2 digits. The dorsal interossei attach to the middle 3 fingers (each usually has 2 heads).

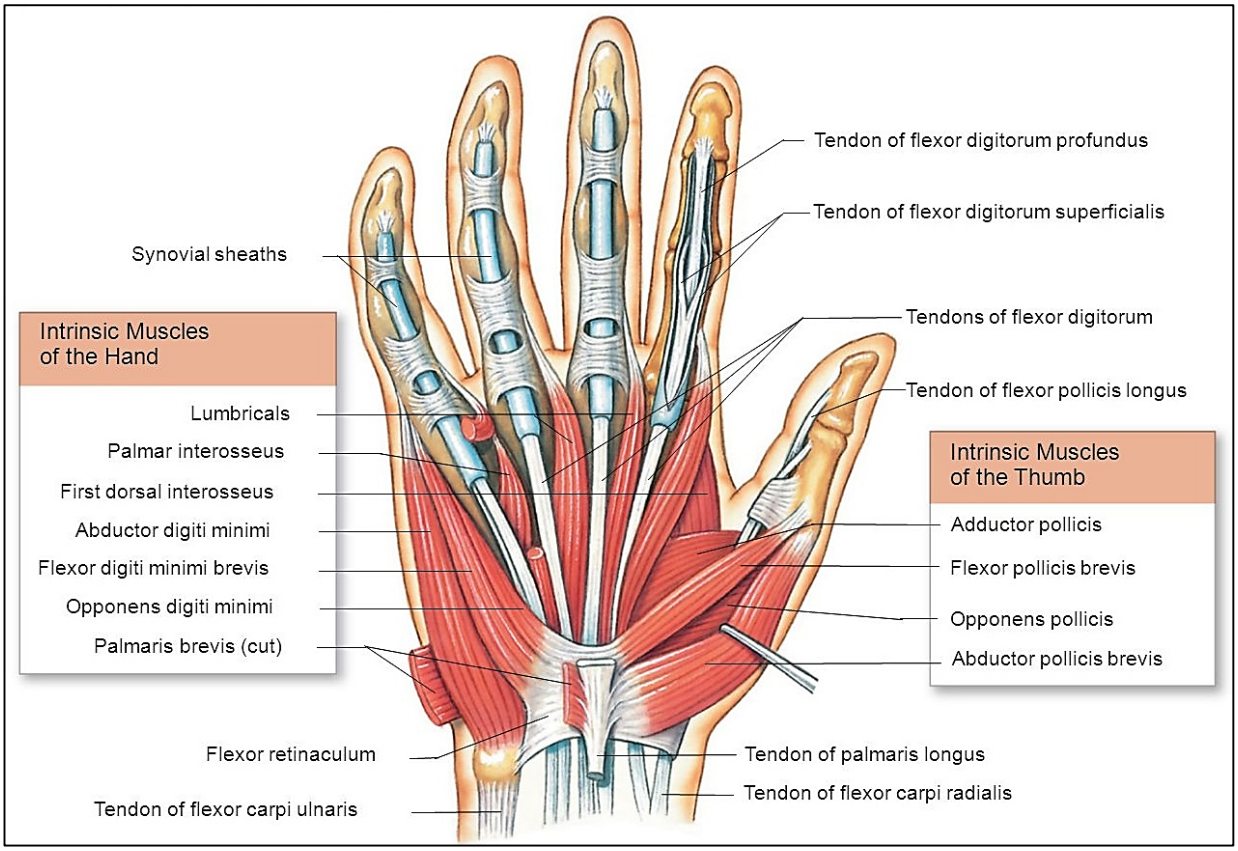


Figure 56: the intrinsic muscle of the right hand.

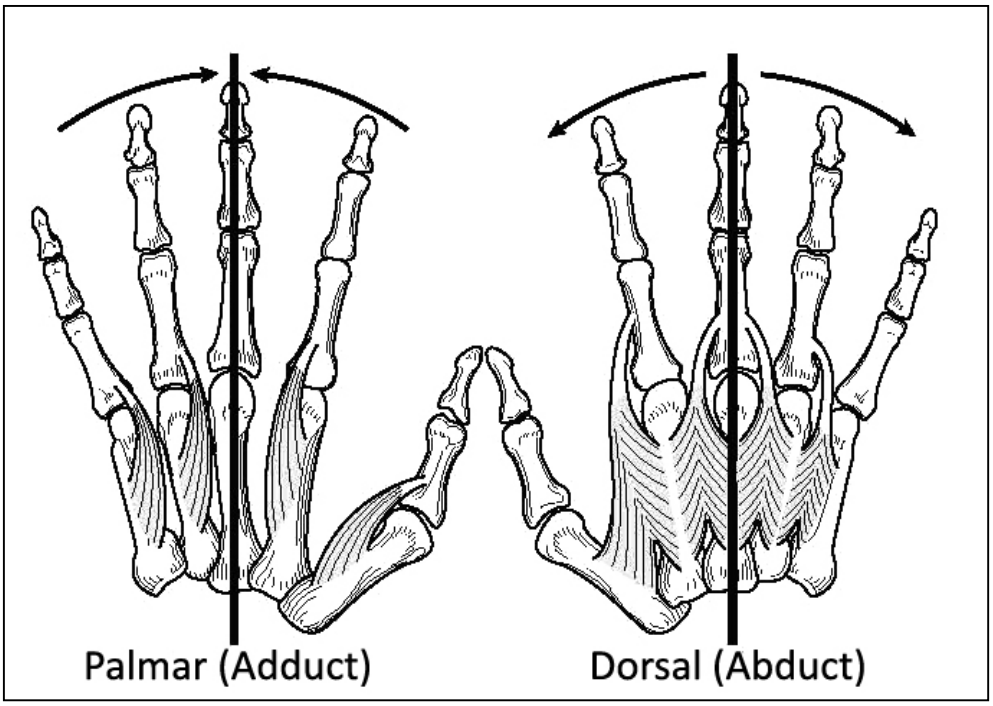


Figure 57: The palmar & dorsal interossei of the right hand.

The extensor (dorsal) expansion [Figure.58]

The extensor expansion is a triangular fascial expansion on the dorsal surface of each digit joined by the tendons of the long extensors, the lumbricals and the interossei. Each expansion consists of two parts;

- The **central part**; is joined by the long extensor tendons i.e. extensor pollicis longus and extensor pollicis brevis for the thumb, extensor indicis and extensor digitorum for the index, extensor digitorum for the middle and ring fingers, extensor digiti minimi and extensor digitorum for the little finger.
- The margins or **peripheral part**; is formed by musculofascial bands derived from the lumbricals and interossei.

Each extensor expansion starts just proximal to the metacrpophalangeal joints and forms a hood over the joint and part of the proximal phalanx. The base of the triangle passes anteriorly on each side of the metacarpal head to the deep transverse metacarpal ligament. The margins of the expansion on each side are thickened by the insertions of the tendons of the corresponding interossei and lumbricals. Each margin spans the 2nd phalanx obliquely starting anterior to the proximal interphalangeal joint and ending dorsal to the distal interphalangeal joint. Distal to the metacrpophalangeal joints, the central part of the extensor expansion receives additional fibers from the margins and splits into 3 bundles:

- The central bundle inserts to the base of the middle phalanx.

- The other peripheral 2 bundles diverge to fuse with the rest of the thick margin and then unite into a single bundle to be inserted to the dorsal surfaces of the distal phalanx.

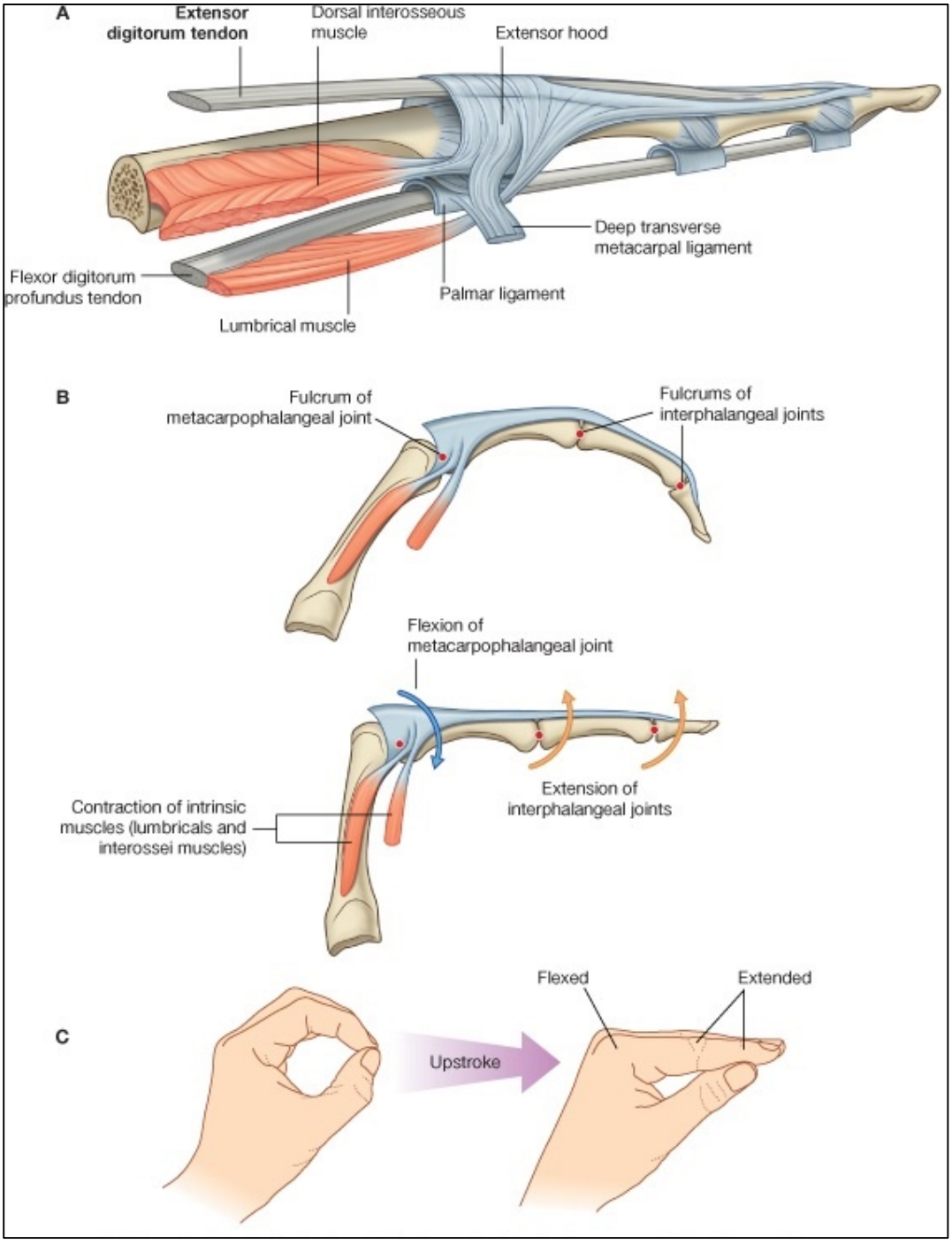


Figure 58: The extensor expansion of the fingers.

Arterial supply of the hand

The ulnar artery

The ulnar artery enters the hand by passing anterior to the flexor retinaculum, lateral to the ulnar nerve. It then divides into two branches;

- A large **superficial palmar** branch; joins with one of the branches of the radial artery to form the superficial palmar arch.
- A smaller **deep branch**; joins the continuation of the radial artery to form the deep palmar arch.

The radial artery

The radial artery enters the hand by winding around the lateral aspect of the wrist over the scaphoid bone to the dorsum of the 1st metacarpal. As it runs deep to the tendon of extensor pollicis longus, it gives proper dorsal digital arteries to both sides of the thumb and to the lateral side of the index. It then leaves the dorsum of the hand towards the palm by passing between the proximal ends of the 1st and 2nd metacarpal bones between the 2 heads of the first dorsal interosseous muscle. Here, it gives two branches:

- The **princeps pollicis** artery; passes to the metacarpal of the thumb and divides into 2 palmar digital arteries, one on each side of the tendon of flexor pollicis longus.
- The **radialis indicis** artery: passes distally to supply the lateral side of the index as the lateral proper digital artery.

Therefore, the radial artery supplies the lateral 1 ½ fingers. After giving these 2 branches, the radial artery continues medially and unites with the deep branch of the ulnar artery to complete the deep palmar arch.

The superficial palmar arch

This arterial arch lies at the level of the distal border of the thenar eminence when the thumb is fully extended. The arch and its branches lie between the palmar aponeurosis anteriorly and the tendons of the long flexors posteriorly. It is formed by the curve of the superficial branch of the ulnar artery with one or more of the following branches from the radial artery: the superficial palmar branch (most commonly), branch of the radialis indicis or princeps pollicis arteries or both. The arch gives 2 groups of palmar digital branches:

- **Proper palmar digital artery of the little finger**; supplies the medial side of the little finger.
- **Three common palmar digital arteries**. These arteries run in the 2nd, 3rd and 4th intermetacarpal spaces towards the interdigital clefts where each of them receives a corresponding **palmar metacarpal artery** from the deep palmar arch and then divides into two proper palmar digital branches to the opposite sides of each two adjacent fingers. **Therefore, the superficial arch supplies the medial 3 ½ fingers**.

The deep palmar arch

The deep palmar arch lies a fingerbreadth proximal to the superficial arch, posterior to the tendons of the long flexors. It represents the continuation of the radial artery as it curves medially to join the deep branch of the ulnar artery. It gives the following branches;

- **Three palmar metacarpal arteries**; which run in the 2nd, 3rd and 4th intermetacarpal spaces to join the distal ends of the common palmar digital arteries of the superficial arch and may sometimes replace them.
- **Palmar and dorsal recurrent carpal branches**; participate in the anastomosis around the wrist.
- **Perforating branches**; perforate the interossei and run posteriorly to join the dorsal metacarpal arteries.

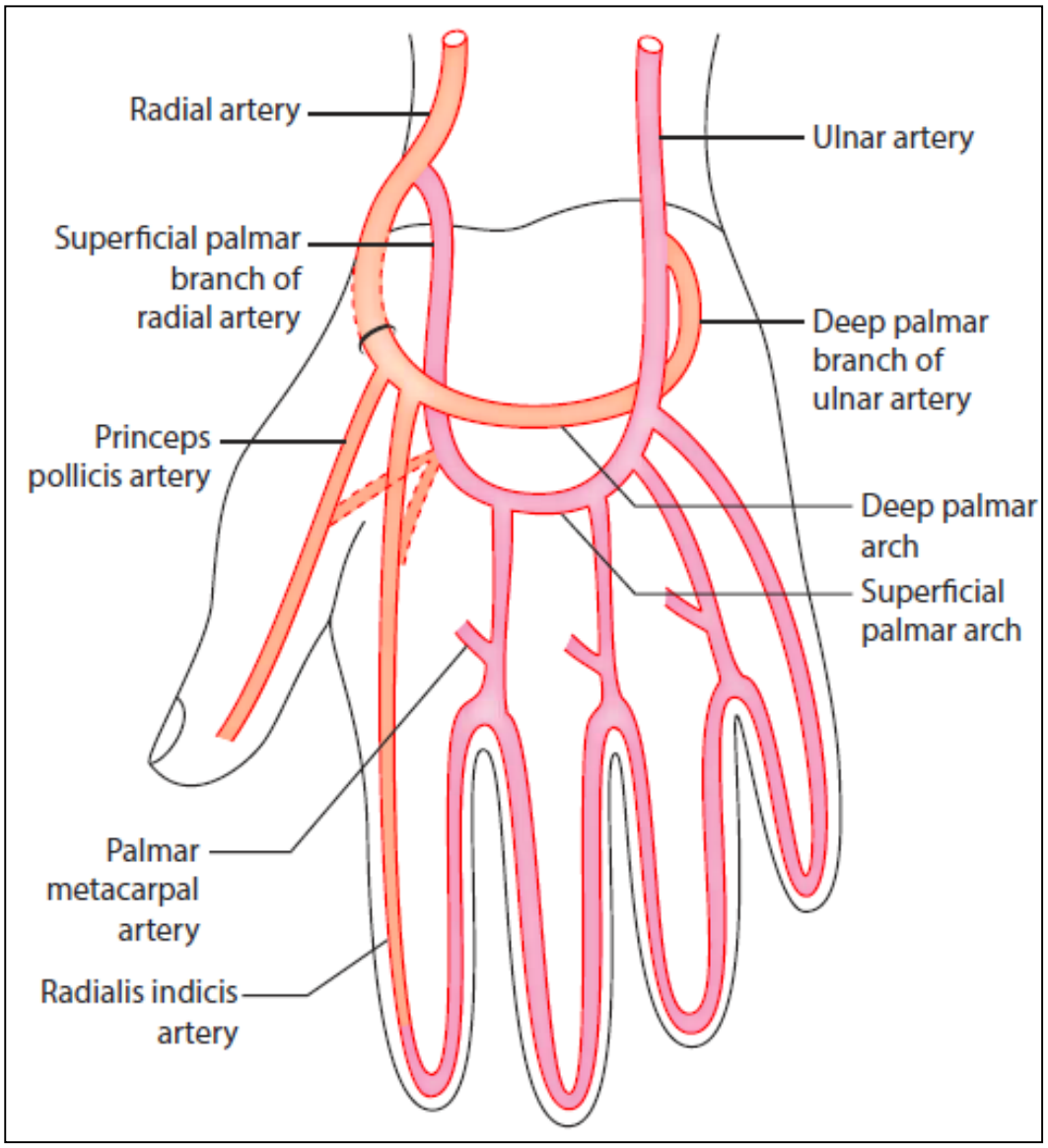


Figure 59: The palmar arterial arches

Arteries of the dorsum of the hand

These arteries are derived from the radial artery and the dorsal carpal rete.

- The radial artery gives three branches to the dorsum of the hand;
  - The **two proper dorsal digital arteries** to both sides of the **thumb**.
  - The **proper dorsal digital artery** to the lateral side of the **index**.
- The dorsal carpal rete (arch) is a mesh of anastomosing arteries on the dorsum of the wrist (i.e. carpal bones) that supplies the dorsal surface of the hand and fingers. It is formed by the dorsal carpal branches of the radial and ulnar arteries, the dorsal recurrent branches of the deep palmar arch and the terminal parts of the anterior and posterior interosseous arteries. The rete gives the following branches to the dorsum of the hand;
  - The **proper dorsal digital artery** of the **little finger**; supplies the medial side of the little finger.
  - **Three common dorsal metacarpal arteries**; run in the 2^{nd}, 3^{rd} and 4^{th} intermetacarpal spaces towards the interdigital clefts where each one receives a perforating branch from the deep palmar arch and then divides into 2 proper dorsal digital arteries to the opposite sides of each two adjacent fingers.

Nerves of the hand

The median nerve [Figure.60]

This nerve enters the hand by passing through the carpal tunnel posterior to the flexor retinaculum, lateral to the tendons of flexor digitorum superficialis and flexor digitorum profundus and medial to the tendon of flexor carpi radialis. Near the distal border of the retinaculum, it divides into 6 branches;

- The **recurrent branch**; is the most lateral branch that enters the thenar compartment to supply flexor pollicis brevis, abductor pollicis brevis and opponens pollicis.
- **Three proper palmar digital nerves**; the first two supply the skin of both sides of the thumb while the third supplies the lateral side of the index and the first lumbrical muscle.
- **Two common palmar digital nerves**; run in the 2^{nd} & 3^{rd} intermetacarpal spaces. The lateral one supplies the second lumbrical, and then they both split into two proper palmar digital nerves to supply the medial side of the index, both sides of the middle and the lateral side of the ring fingers.

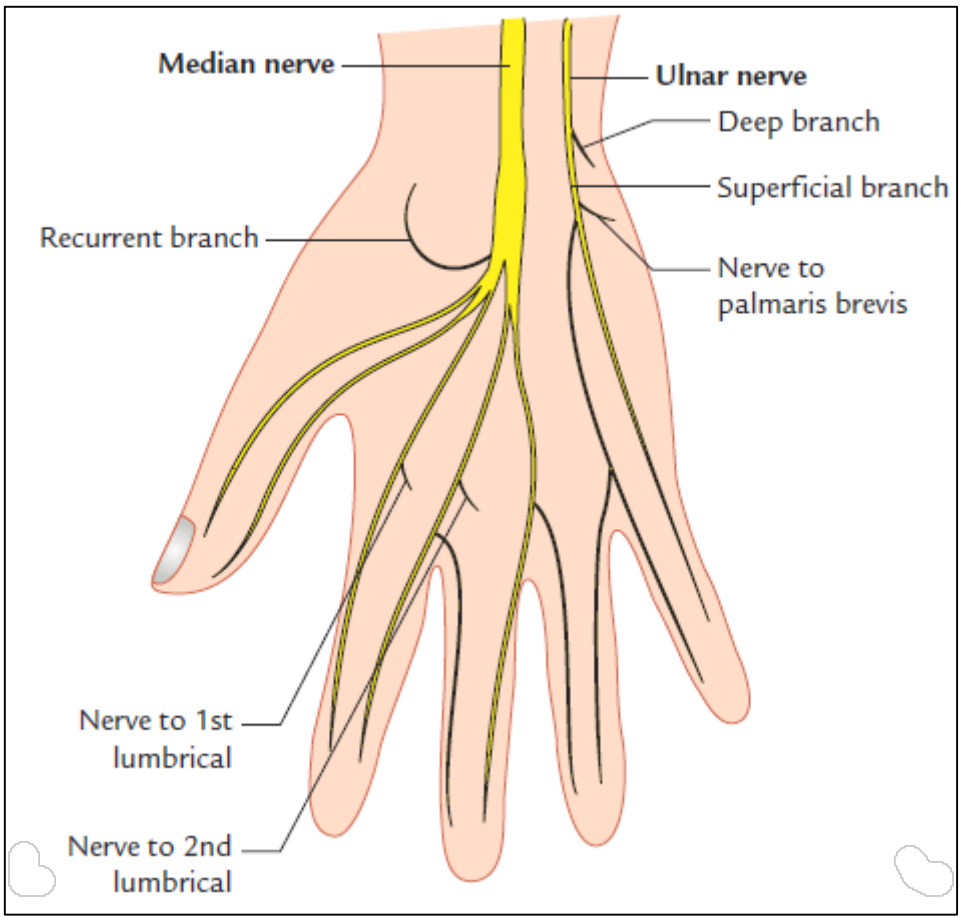


Figure 60: The median & ulnar nerves in the hand.

The ulnar nerve [Figure.61]

The ulnar nerve enters the hand by passing anterior to the flexor retinaculum where it divides into superficial and deep branches.

- The **superficial branch**; supplies palmaris brevis muscle, and then passes deep to it to divide into a **proper palmar digital nerve** to the medial side of the **little finger** and a **common palmar digital nerve**. The common palmar digital nerve runs in the 4th intermetacarpal space, communicates with the adjacent common palmar digital branch of the median and then divides into two proper palmar digital nerves to the opposite sides of the little and ring fingers.
- The **deep branch**; supplies the hypothenar muscles and passes with the deep branch of the ulnar artery and curves laterally across the metacarpal bases to reach and supply the medial two lumbricals (i.e. 3rd & 4th), all the interossei and adductor pollicis.

The superficial branch of the radial nerve

This nerve passes posterior to the lateral part of the extensor retinaculum to supply the lateral $^{2}/_{3}$ of the dorsum of the hand, the ball of the thumb and the lateral 3½ fingers via 5 dorsal digital nerves. It supplies the dorsum of the digits only to the level of the proximal

interphalangeal joints. Sometimes, the superficial branch of the radial nerve supplies only the lateral $2^1/_2$ fingers dorsally, in which case the medial $2^1/_2$ fingers are supplied by the ulnar nerve.

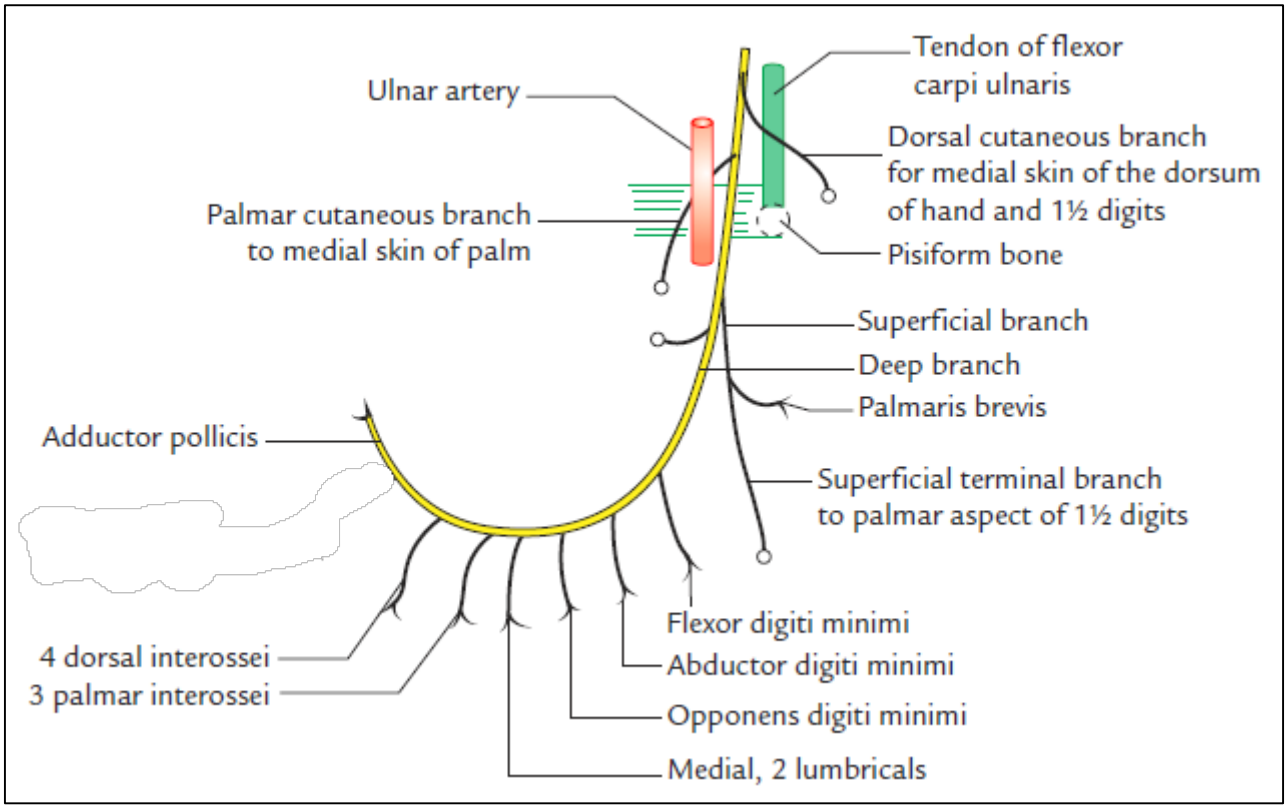


Figure 61: Distribution of the ulnar nerve in the hand.

Small joints of the hand

The Intercarpal joints

The synovial **plane** joints between the carpal bones share a common articular cavity. The fibrous capsule of the joints is reinforced by numerous ligaments. Although movement at the intercarpal joints is limited, they do contribute to the positioning of the hand in abduction, adduction, flexion, and, particularly, extension.

The carpometacarpal joints

There are five carpometacarpal joints between the metacarpals and the related distal row of carpal bones. The bones of the distal row articulate with the metacarpal bones at the **carpometacarpal joints** as follows:

- The trapezium with the 1st metacarpal.
- The trapezoid with the 2nd metacarpal.
- The capitate with the 3rd and part of the 2nd metacarpal.
- The hamate with 4th and 5th metacarpals.

The **saddle** joint between first metacarpal and the trapezium is the **carpometacarpal joint of the thumb** that has a wide range of mobility that is not a feature of the rest of the digits. Movements at this carpometacarpal joint are flexion, extension, abduction, adduction and circumduction produced by the long and short muscles of the thumb.

The c**arpometacarpal joints** between **2nd to the 5thmetacarpals** and the carpal bones are simple **plane** joints allowing only limited gliding movements. Movement of the joints increases medially so that the 5th metacarpal slides to the greatest degree.

The metacarpophalangeal joints

These are synovial **condylar** joints formed between the distal heads of the metacarpals and the proximal phalanges of the digits. They allow flexion, extension, abduction, adduction, and circumduction. The capsule of each joint is reinforced by **medial and lateral collateral ligaments**. The **deep transverse metacarpal ligament** connects the capsules of the metacarpophalangeal joints of the medial 4 fingers to each other.

The interphalangeal joints

The interphalangeal joints of the hand are **hinge** joints that allow mainly flexion and extension. They are reinforced by **medial and lateral collateral ligaments** and **palmar ligaments**.

Nerve injuries in the upper limb

Peripheral nerve injuries may result from either division (complete or partial) or compression of the nerve. In nerve division, the muscles supplied by the nerve will be paralyzed and sensation is lost (anesthesia) in the skin area supplied by the nerve *distal to the site of injury.* In nerve compression, the muscles supplied by the nerve become weakened not paralyzed and there will be abnormal sensation of pins and needles in the skin (paresthesia) *distal to the site of injury.* Proximal to the site of injury, the muscles and skin supplied by the nerve or its branches remain intact.

Brachial plexus injuries

Complete lesions of all the roots of the brachial plexus are rare. Incomplete injuries are common and are usually caused by traction or pressure; they may affect the upper or lower parts of the plexus.

Upper lesions of the brachial plexus

These lesions result from depression of the shoulder on the same side of the affected limb and excessive displacement of the head to the opposite side. It usually occurs in newborns

of difficult delivery or in adults after a blow to or a fall on the shoulder. The injury causes excessive traction or even tearing of **C5 and C6 roots** affecting the following nerves;

- The suprascapular nerve; causing paralysis of supraspinatus (the initiator of abduction) and infraspinatus (a lateral rotator of the shoulder).
- The nerve to subclavius; causing paralysis of the subclavius and loss of its function.
- The musculocutaneous nerve; causing paralysis and loss of the functions of biceps brachii (elbow flexion and supination and shoulder flexion), coracobrachialis (shoulder flexion) and most of brachialis (elbow flexion).
- The axillary nerve; causing paralysis of deltoid (mainly shoulder abduction is affected) and teres minor (a lateral rotator of the shoulder).

The combination of these motor effects cause the limb to hang limply by the trunk, medially rotated by the unopposed action of the sternocostal fibers of pectoralis major with the elbow extended and the forearm pronated (loss of supination); a combination known as **Erb-Duchenne Palsy (waiter's tip position).** Although supinator is not supplied by any of the mentioned nerves but it is also paralyzed since it is supplied by C6 fibers running through the radial nerve.

In addition to the motor effects, there is sensory loss over the lateral side of the arm and forearm (C5 and C6 dermatomes). The paralysis of subclavius leads to loss of its protective effect to the sternoclavicular joint. Repeated hammering of the clavicle on the manubrium sterni will result in accelerated joint damage.

Lower lesions of the brachial plexus

These lesions are usually caused by excessive abduction of the arm as in a person falling from a height and clutching at an object to save themselves. They can also be produced by the presence of a cervical rib or the presence of enlarged lower deep cervical lymph nodes.

The **T1 fibers** are mainly affected. T1 fibers run in the ulnar and median nerves to supply all the small muscles of the hand. As these muscles become paralyzed the following features occur;

- The extensor action of the long extensors is unopposed by the flexor action of the lumbricals and interossei at the metacarpophalangeal joints causing hyperextension of these joints.

- The flexor action of flexor digitorum superficialis and flexor digitorum profundus is unopposed by the extensor action of the lumbricals and interossei at the interphalangeal joints causing flexion of these joints.

The combined metacarpophalangeal hyperextension and interphalangeal flexion gives the hand a **clawed appearance**.

There is sensory loss along the medial side of the arm (T1 dermatome) and if the C8 root is also affected the loss extends to the forearm, medial $^1/_3$ of the palm and medial 1½ fingers (C8 dermatome).

Long thoracic nerve injury

This may be injured by blows or pressure on the posterior triangle of the neck or during radical mastectomy. Its damage causes paralysis of serratus anterior muscle resulting in weakened lateral rotation of the scapula during abduction and loss of the muscle tone causes loss of its effect in holding the scapula against the rib cage. The patient suffers from difficulty in raising the arm above the head i.e. abduction of the shoulder above the horizontal plane. The medial border and inferior angle of the scapula protrude posteriorly; a condition known as **winging of the scapula**.

Axillary nerve injury

This nerve is commonly injured in inferior dislocation of the shoulder or fractures of the surgical neck of the humerus. The following features occur;

- Failure to abduct the shoulder beyond 15-30^o due to paralysis of deltoid. The little amount of abduction possible is the action of supraspinatus.
- Loss of sensation over the lower ½ of deltoid muscle (area of the upper lateral cutaneous nerve of the arm).

Radial nerve injury

In the axilla

Damage to the radial nerve in the axilla is commonly caused by the pressure of the upper end of a badly fitting crutch pressing up into the armpit or by fractures and dislocations of the proximal end of the humerus. Such damage results in the following features:

Motor

- The triceps and anconeus are paralyzed and elbow extension is lost.
- All the muscles of the posterior compartment of the forearm; long extensors of the wrist and fingers; are paralyzed causing the unopposed flexors to flex the wrist and

fingers and **wrist drop** results. With the wrist flexed, the fingers cannot be flexed tightly for a firm grip. If the proximal phalanges and wrist are passively extended by the other hand, the interphalangeal joints can be extended by the action of the lumbricals and interossei via the extensor expansion.

- Although brachioradialis and supinator are also paralyzed, **supination is still possible** in elbow flexion by the action of biceps brachii.

Sensory:

- There is sensory loss of the lower lateral and posterior parts of the arm and in the narrow strip in the middle of the back of the forearm (lower lateral and posterior cutaneous nerves of the arm and posterior cutaneous nerve of the forearm).
- There is sensory loss over the dorsal $^{2}/_{3}$ of the hand and the roots of the lateral 3 ½ fingers.

In the radial groove

Damage to the radial nerve in the radial groove is commonly caused by fractures of the shaft of the humerus (mainly the distal part) resulting in the following features;

Motor

- The effect on the long extensors, brachioradialis and supinator is the same as in injuries in the radial groove mentioned earlier.
- Triceps and anconeus are spared and elbow extension is not affected because their nerve supply arises proximal to the site of injury (branches to the long and medial heads of triceps arise in the axilla and branches to the lateral and medial heads and to anconeus arise in the proximal part of the radial groove).

Sensory

- There is sensory loss over the dorsal $^{2}/_{3}$ of the hand and the roots of the lateral 3 ½ fingers.
- The lower lateral arm and posterior part of the forearm are spared since their nerves arise proximal to the site of injury.

Injury to the superficial branch of the radial nerve

This injury may result from stab wounds causing sensory loss over the area of the hand supplied by this nerve.

Injury to the deep branch of the radial nerve

The deep branch of the radial nerve may be injured in fractures or dislocations of the proximal end of the radius. Since the nerve is motor only, there will be no sensory loss.

Because Supinator, brachioradialis and extensor carpi radialis longus are supplied by the radial nerve or its deep branch at a more proximal level they will not be damaged. Extensor carpi radialis longus is a powerful extensor that will keep the wrist extended and wrist drop will not occur. However, there still will be weakness of the long extensors of the digits that is compensated by the actions of the lumbricals and interossei.

Median nerve injury

At the elbow

The median nerve may be injured at the elbow by supracondylar fractures of the humerus or may be trapped between the two heads of pronator teres resulting in the following effects;

Motor

- All the muscles of the flexor compartment of the forearm are paralyzed; except flexor carpi ulnaris and the medial 2 tendons of flexor digitorum profundus. As a result, the forearm is kept in supine position. Wrist flexion is weak but not lost because flexor carpi ulnaris flexes the wrist but also adducts it.
- The little and ring fingers flex (normal medial 2 tendons of flexor digitorum profundus) more than the index and middle fingers at the interphalangeal joints (Benediction sign). The interossei can perform weak flexion at the metacarpophalangeal joints of the index and middle fingers but the first 2 lumbricals are paralyzed. This causes the index and middle fingers to lag behind the ring and little fingers when an attempt is made to make a fist slowly.
- Flexion of the terminal phalanx of the thumb is lost due to paralysis of flexor pollicis longus.
- The thenar muscles are paralyzed and wasted and the thenar eminence becomes flattened. The thumb is adducted and laterally rotated and cannot be opposed to other fingers. The hand looks flattened and **apelike**.

Sensory

Sensory loss occurs in the skin of the lateral $^{2}/_{3}$ of the palm and the lateral 3½ fingers extending on the dorsum of the fingers to the level of the proximal interphalangeal joints.

At the wrist

This is commonly caused by stab wounds or broken glass dividing the nerve as it passes posterior to the flexor retinaculum. The clinical findings are;

The apelike hand and damage to the thenar muscles as in damage at the elbow mentioned earlier. The muscles of the forearm are not affected and wrist movement is intact.

Sensory loss occurs in the skin of the lateral $^{2}/_{3}$ of the palm and the lateral 3½ fingers extending on the dorsum of the fingers to the level of the proximal interphalangeal joints.

The median nerve is more commonly **compressed** at the wrist by excessive synovial fluid in the ulnar and radial bursae; a condition known as **carpal tunnel syndrome**. In this case, the thenar muscles will be weakened not paralyzed and the paresthesia will be limited to the fingers only. The skin of the lateral $^{2}/_{3}$ of the palm is spared because the palmar cutaneous branch of the median nerve runs anterior to the flexor retinaculum and thus escapes being compressed by the synovial sheaths.

Ulnar nerve injury

At the elbow

Injury of the ulnar nerve at the elbow is common and is associated with fractures of the medial epicondyle of the humerus. It may also be trapped between the two heads of flexor carpi ulnaris. The clinical findings include;

Motor

- Paralysis of flexor carpi ulnaris weakens wrist flexion and when the patient attempts to flex the wrist the movement is associated with lateral deviation due to the unopposed action of flexor carpi radialis.
- Paralysis of the medial 2 tendons of flexor digitorum profundus prevents flexion of the distal interphalangeal joints of the little and ring fingers.
- All the small muscles of the hand (including adductor pollicis) will be paralyzed; except the thenar muscles and the first 2 lumbricals which are supplied by the median nerve. The thumb cannot be adducted due to paralysis of adductor pollicis, the fingers cannot be abducted and adducted due to paralysis of the dorsal and palmar interossei and the metacarpophalangeal joints will be hyperextended while the interphalangeal joints will be flexed due to paralysis of the lumbricals and interossei. The resulting deformity is called the **claw-hand** deformity. The deformity is more prominent in the little and ring fingers because the first 2 lumbricals are not paralyzed. The distal interphalangeal joints of the index and middle fingers are flexed by the tension in the flexor digitorum profundus tendons.

Sensory

The entire skin area of ulnar nerve supply will show sensory loss i.e. the medial $^{1}/_{3}$ of the hand and medial 1½ fingers anteriorly and posteriorly.

At the wrist

Because of its superficial position at the wrist, the ulnar nerve is commonly injured here by stab wounds or suicidal cuts. The effects are;

Motor

The claw hand deformity is similar to that seen in injuries at the elbow except that the distal interphalangeal joints of all fingers are flexed by the tension in the flexor digitorum profundus tendons since both parts of the muscle are functional.

Sensory

The main ulnar nerve and its palmar cutaneous branch are affected but the dorsal cutaneous branch is usually spared since it arises at a level more proximal to the injury. Therefore, the sensory loss is limited to the medial $^{1}/_{3}$ of the palm and the palmar surface of the medial 1 ½ fingers extending dorsally to the level of the proximal interphalangeal joints.

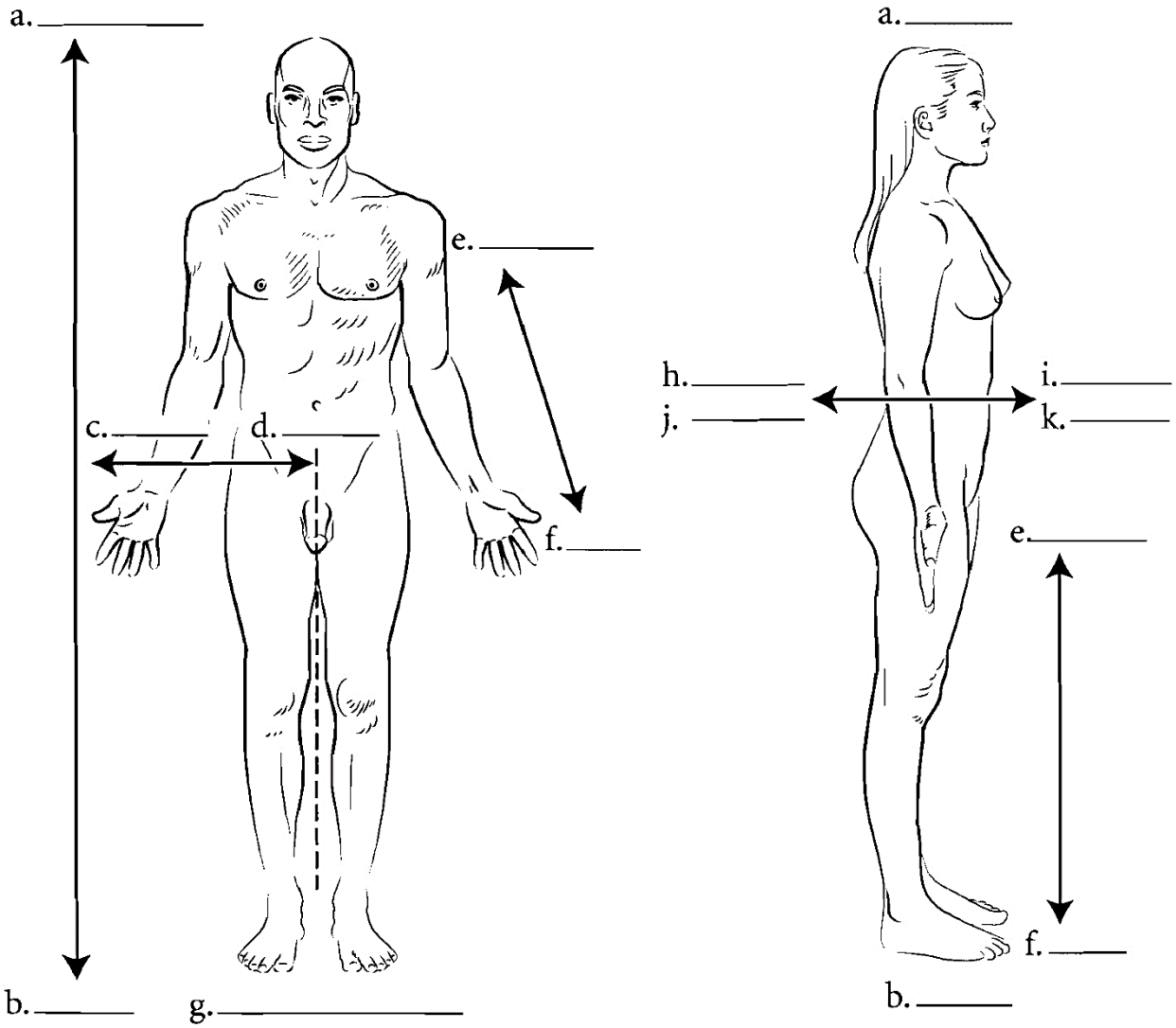
Combined ulnar and median nerve injury

A combined injury to the ulnar and median nerves at the elbow causes a true claw hand of severe type. The wrist joint is hyperextended due to paralysis of all the flexors and the unopposed action of the extensors of the wrist joint. The metacarpophalangeal joints are hyperextended due to paralysis of the lumbricals and interossei. The long extensors cannot extend the interphalangeal joints but they hyperextend the metacarpophalangeal joints because the palmar plate with the attached dorsal expansion are drawn distally to the metacarpal heads. The interphalangeal joints are partially flexed due to the tension of the long flexors and not due to their tone since they are paralyzed. This sever type of claw hand may also be seen in injuries to the medial cord of the brachial plexus.

LAB WORKBOOK

Terms of position, orientation & movement

1. **Use the terms of direction and relation to fill in the blanks in the diagram below.**



2. **Complete the following sentences:**

a- Just as the arm is superolateral to the abdomen, the chin is …….. to the ear.

b- The skin is …… to bone, the bone is…… to skin and skeletal muscles are

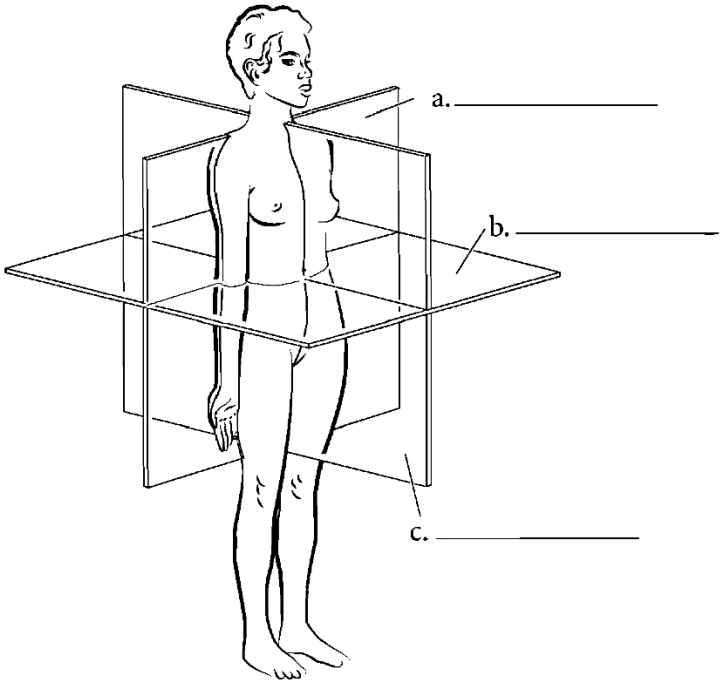
……..

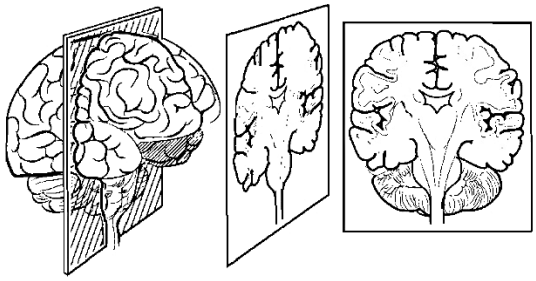
c- The term anterior is replaced in the trunk by the term……

d- The most distal part of the upper limb is the ……

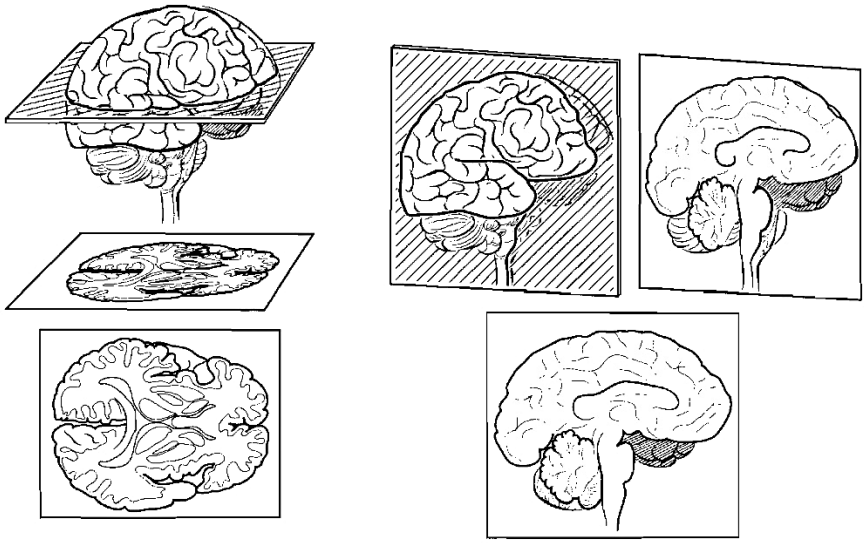
Body planes & Movement

1. **Indicate which plane or section is used in each of the diagrams below.**





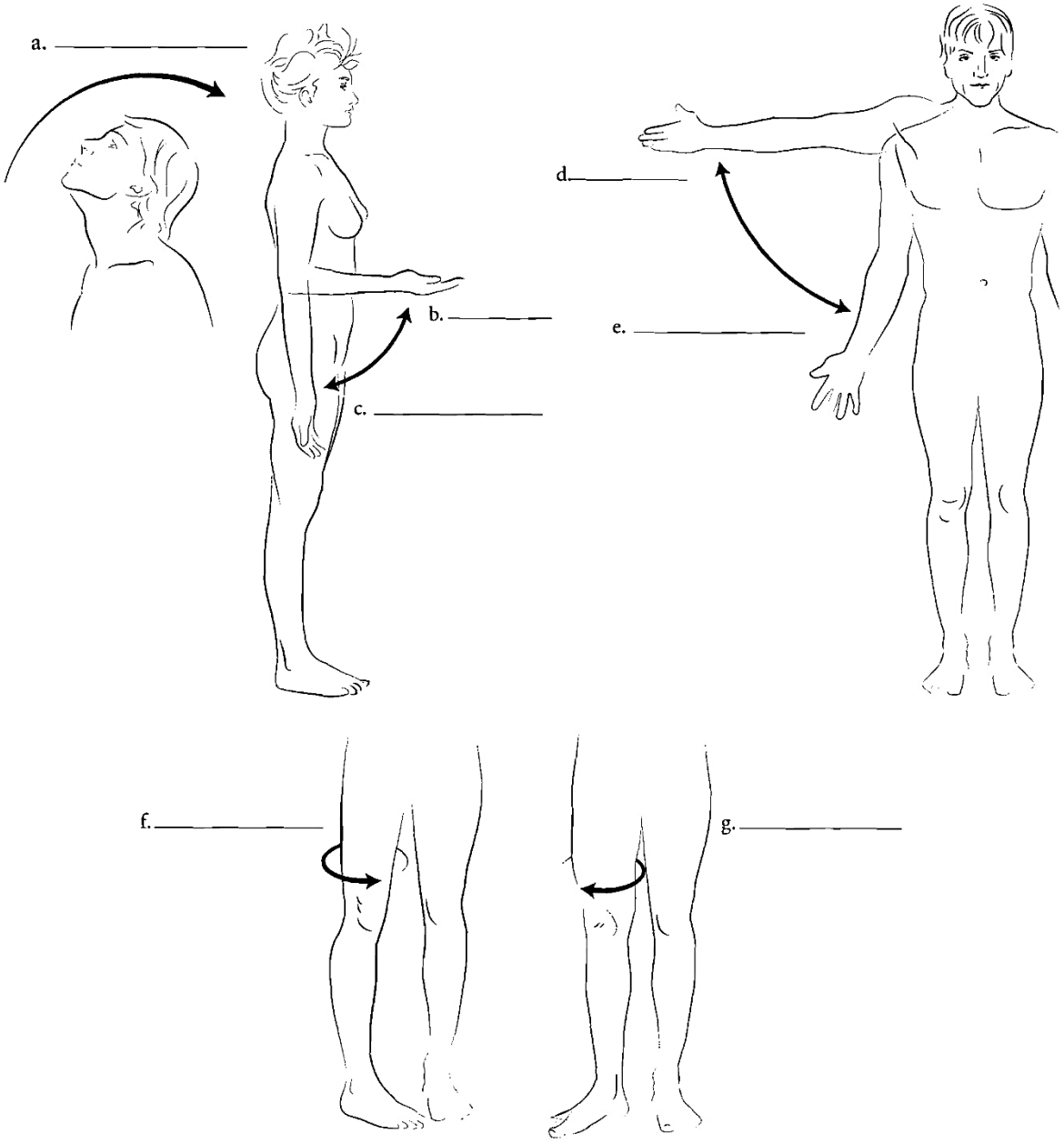
a. _____



b. _____ c. _____

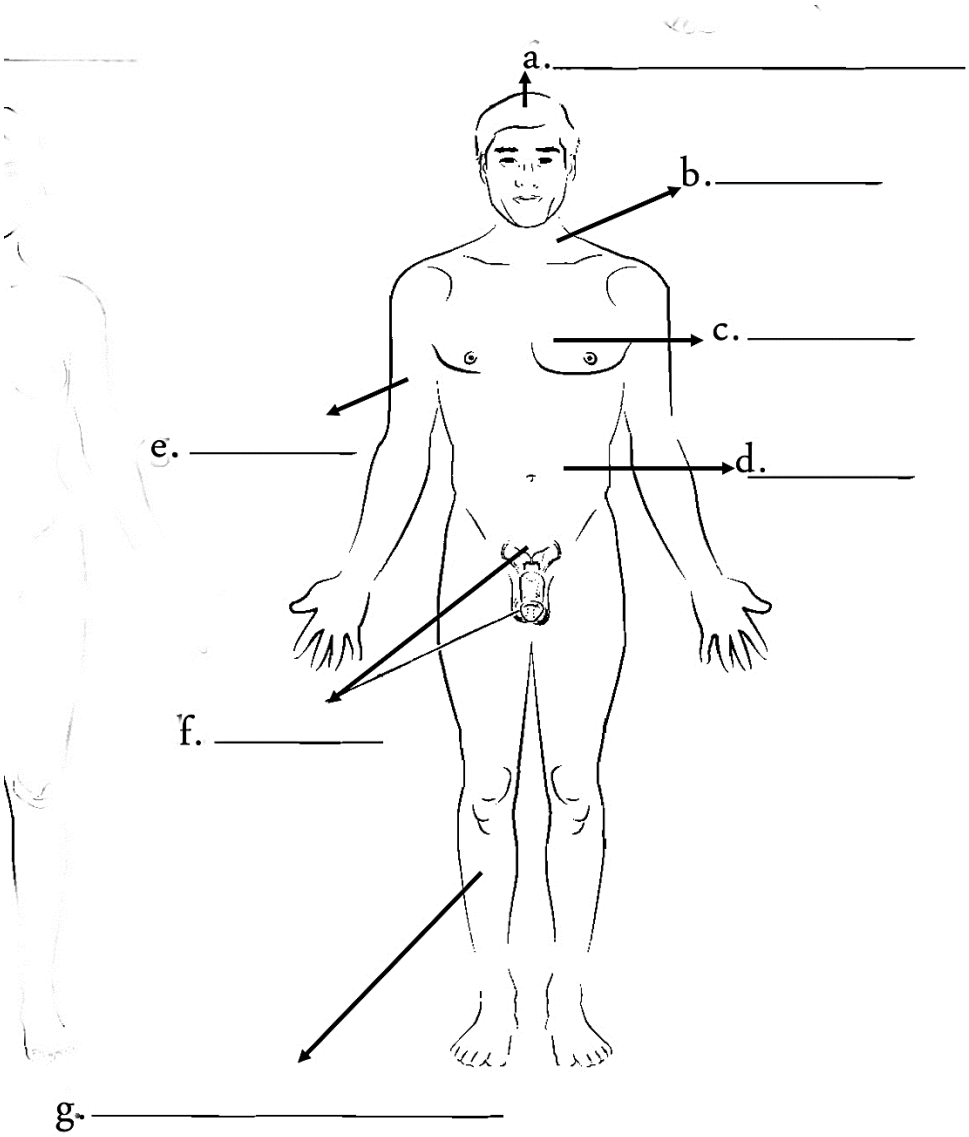
2. **Practice the movements of the shoulder, elbow, wrist & fingers.**

3. Label the movements shown in the diagram below.



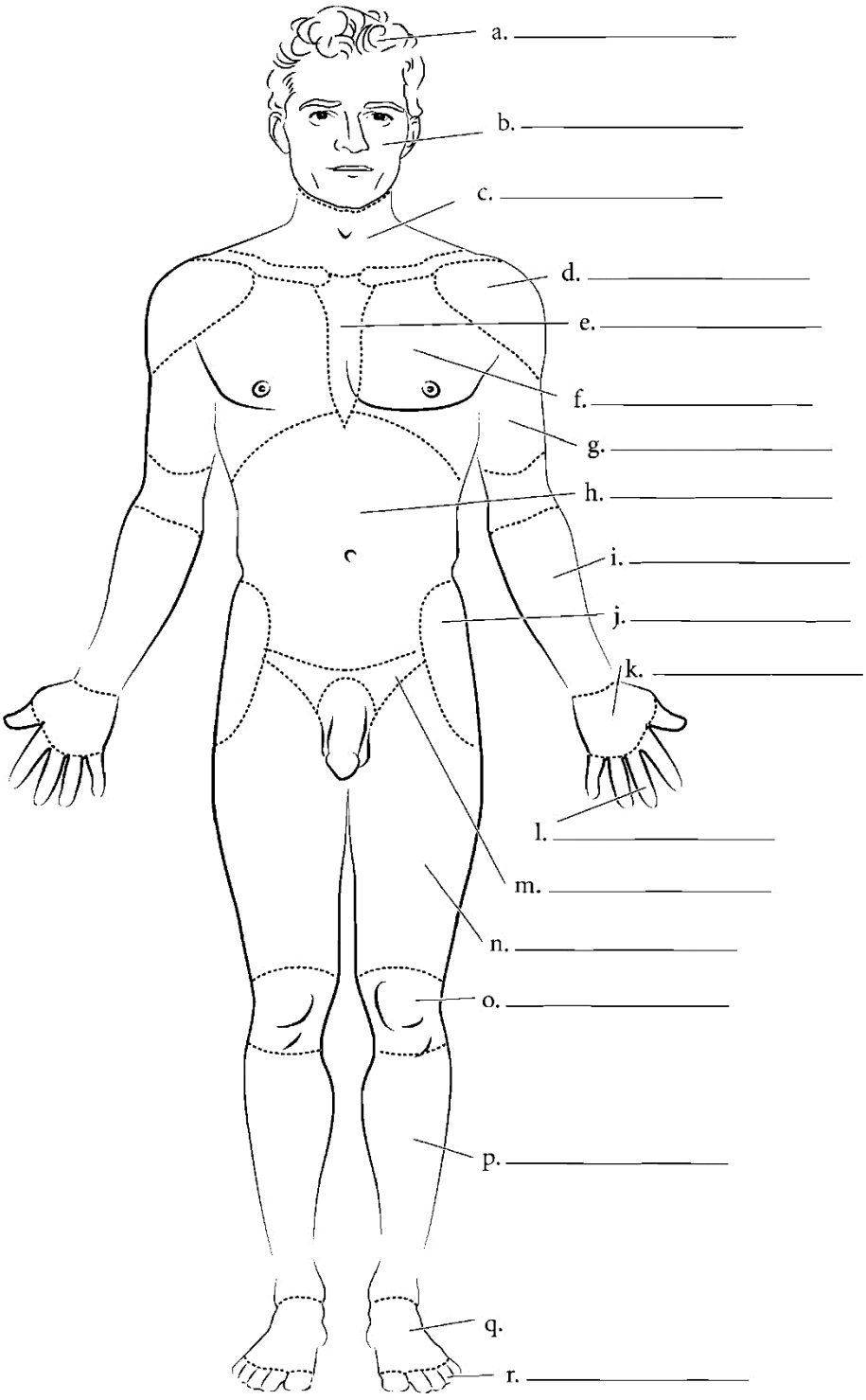
The regions & subregions of the body

1. Name the major body regions on the diagram below.



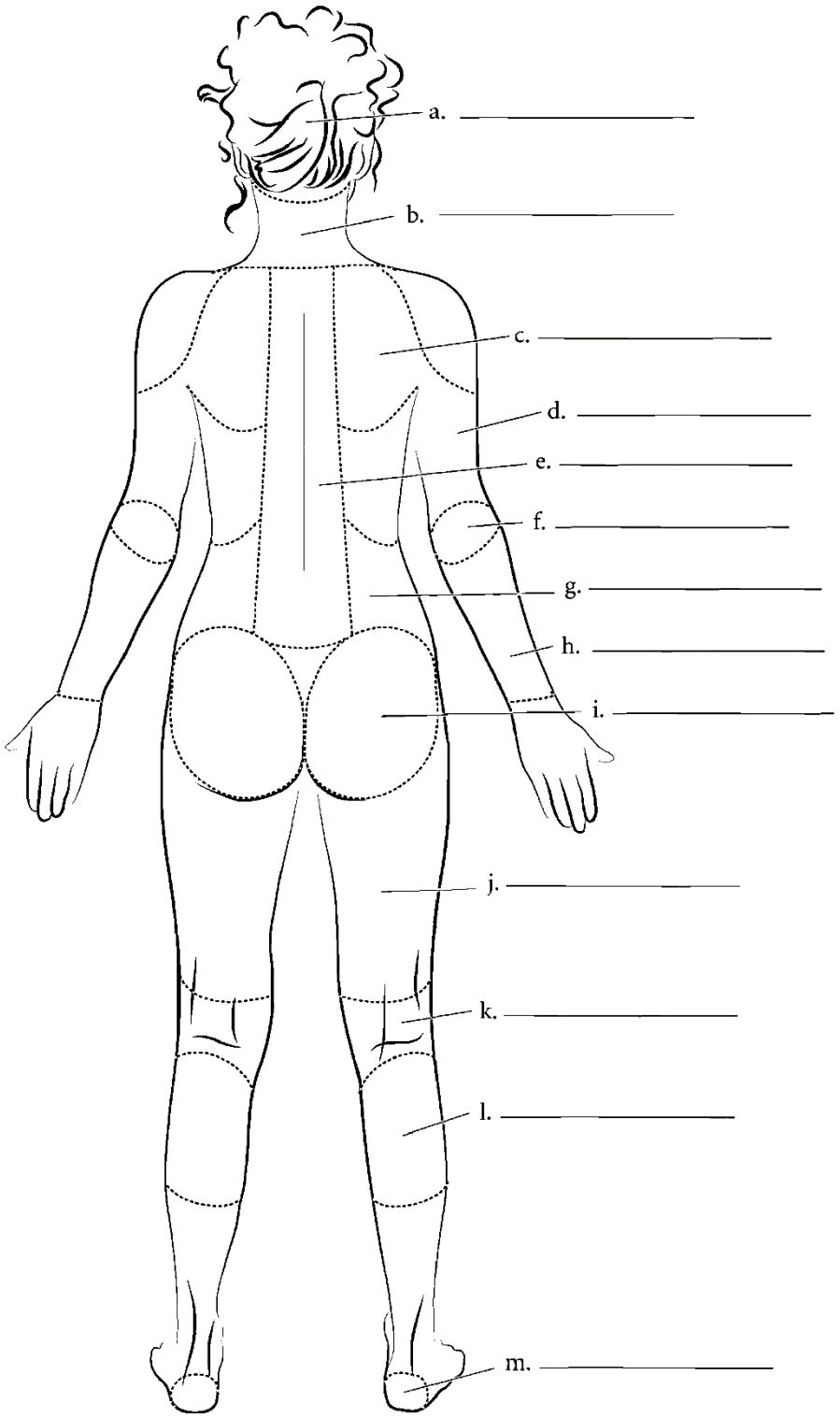
2. **Use the list to the left to learn the names and references of the subregions of the anterior surface of the body.**

cranial (head)
facial (face)
cervical (neck)
deltoid (shoulder)
pectoral (chest)
sternal (center of chest)
brachial (arm)
antebrachial (forearm)
manual (hand)
digital (fingers)
abdominal (belly)
inguinal (groin)
coxal (hip)
femoral (thigh)
genicular (knee)
crural (leg)
pedal (foot)
digital (toes)



3. Use the list to the left to learn the names and references of the subregions of the posterior surface of the body.

cephalic (head)
nuchal (neck)
scapular (shoulder blade)
vertebral (backbone)
lumbar (love handles)
brachial (arm)
olecranon (elbow)
antebrachial (forearm)
gluteal (buttocks)
femoral (thigh)
popliteal (back of knee)
sural (calf)
calcaneal (heel)



Basic anatomical structures

1. **Enumerate the epidermal appendages.**

…… …… ……

……

2. **What is the difference between superficial fascia and deep fascia?**

……

……

3. **Give three locations where you would find smooth muscles.**

…… …… ……

…… …… ……

4. **Name the expected movement (action) for these examples of skeletal muscles.**

Muscle	Origin	Insertion	Action
1	Back of the skull	Top of the shoulder	
2	Front of the forearm	Tips of the fingers	
3	Buttocks	Back of the leg	

5. **Match each of the following skeletal muscle to its naming method:**

Muscle	Naming method
( ) Extensor digitorum	1. Location
( ) External oblique abdominis	2. Number of heads
( ) Deltoid	3. Action
( ) Biceps brachii	4. Shape

6. List four differences between arteries and veins.

Arteries	Veins

7. Which anatomical type of bone is each of the following:

a- Thigh bone (femur):

b- Shoulder blade (scapulae):

c- A vertebra:

d- Knee cap (patella):

e- Finger bones (phalanges):

8. Give an example of each of the following joints:

a- Fibrous joint:

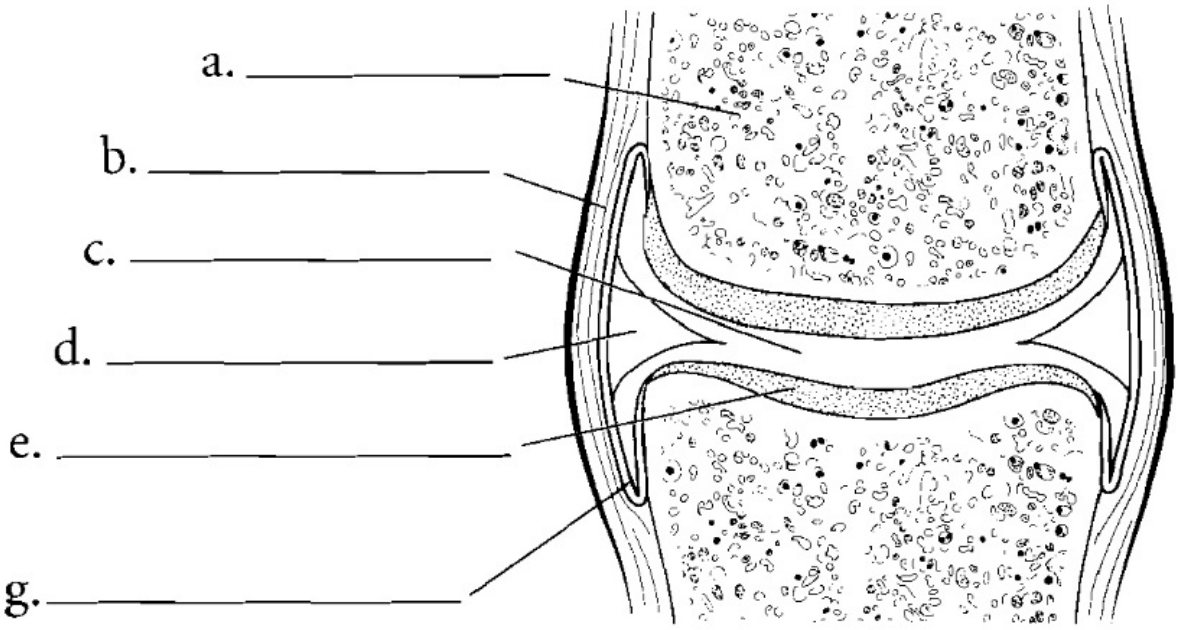
b- Primary cartilaginous joint:

c- Secondary cartilaginous joint:

d- Ball and socket synovial joint:

e- Hinge synovial joint:

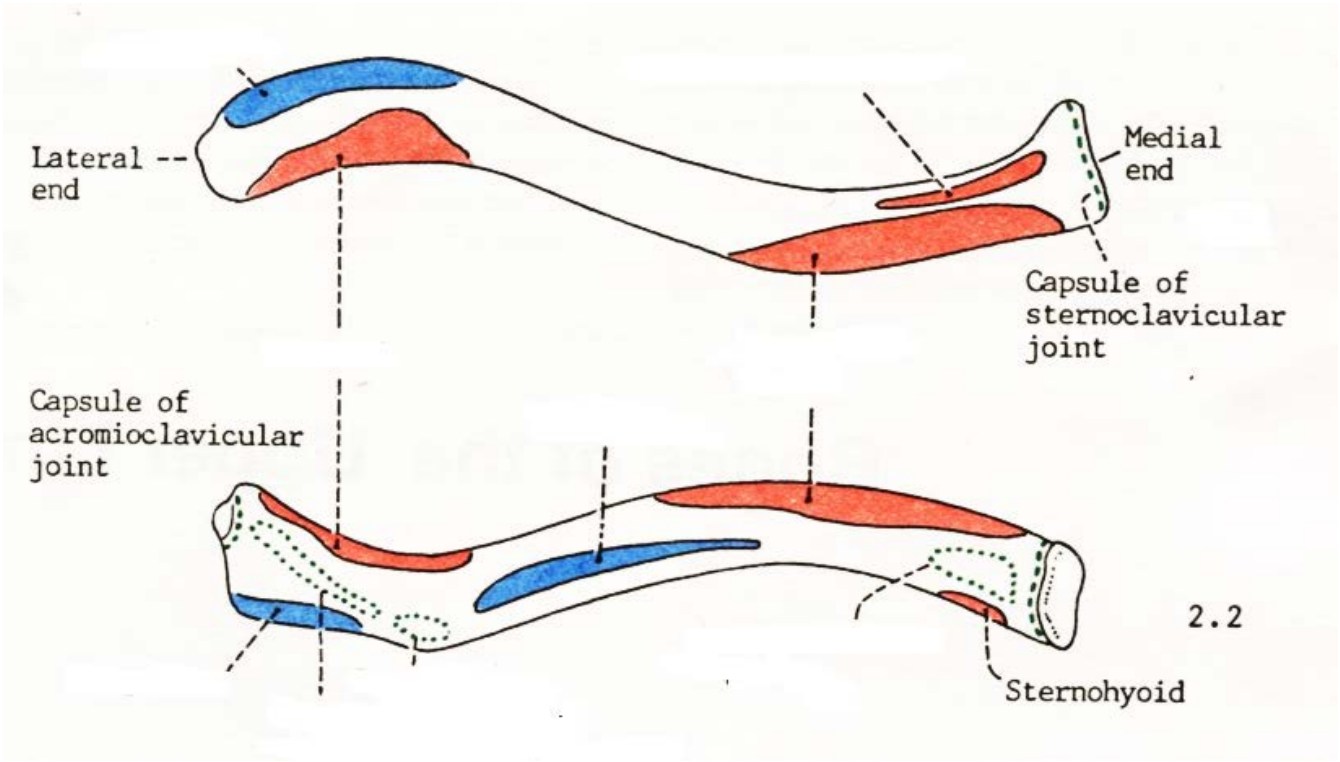
9. Label the diagram below showing the structure of a typical synovial joint.



10. Draw a labelled diagram showing a cross section of the spinal cord and a typical spinal nerve.

The clavicle

1. **Identify the osteological markings of the fresh clavicle in front of you and decide whether it's right or left. Position the clavicle on your body in the correctly.**
2. **Using the diagram below, identify the muscular & ligamentous attachments of the clavicle.**



The scapula

1. **Identify the osteological markings of the scapula (borders, angles, fossae, tubercles, notches).**

The pectoral region & breast

1. **Identify the muscles of the pectoral region on the plastic specimens and cadaver.**
2. **Identify the nipple, areola, mammary gland and submammary region on the plastic specimen of the breast.**

Review questions:

I. By moving the clavicle, pectoralis major can perform this movement on the scapula:

A. protraction B. retraction C. lateral rotation D. elevation

II. A 25 year old female presented with a dried infected nipple, on examination the doctor found these lymph nodes to be enlarged:

A. apical B. parasternal C. pectoral D. infraclavicular

III. ONE of the following structures is NOT a posterior relation of the breast:

A. Pectoralis major muscle. B. Clavipectoral fascia.

C. Serratus anterior muscle. D. Teres minor muscle.

VI. Complete the labeling of the diagram below

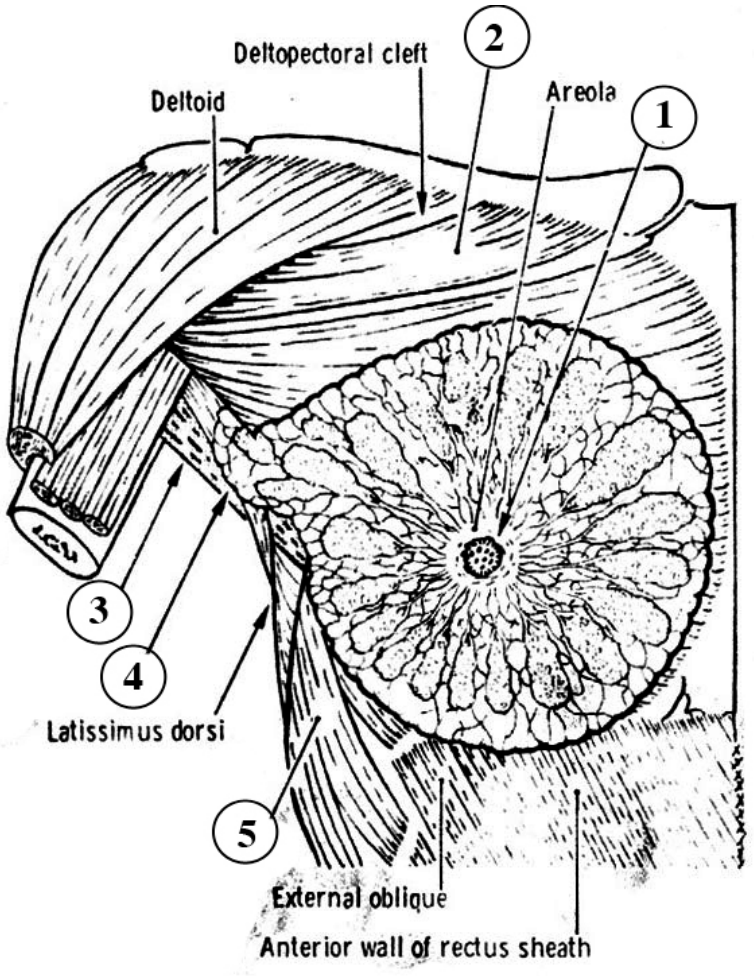
1……..

2……

3……..

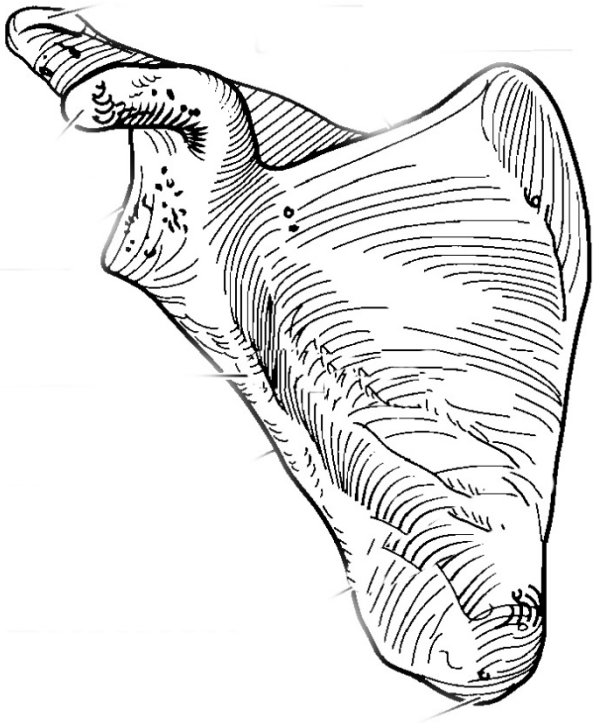
4……

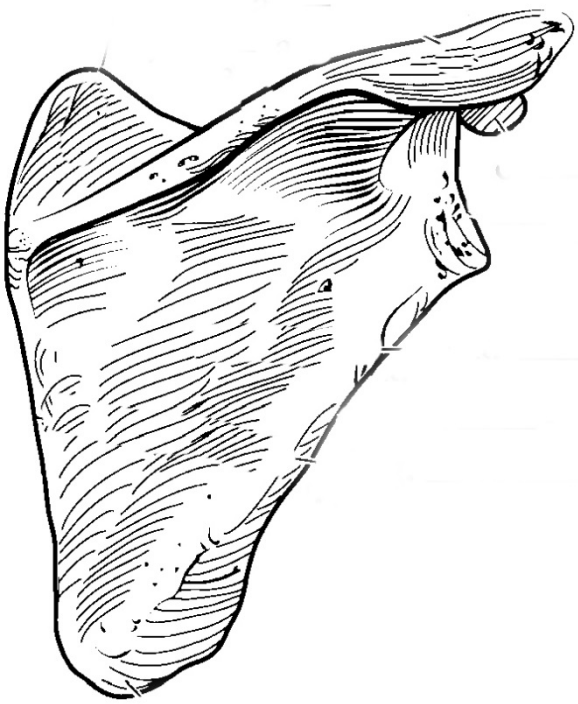
5……..



The dorsal scapular region

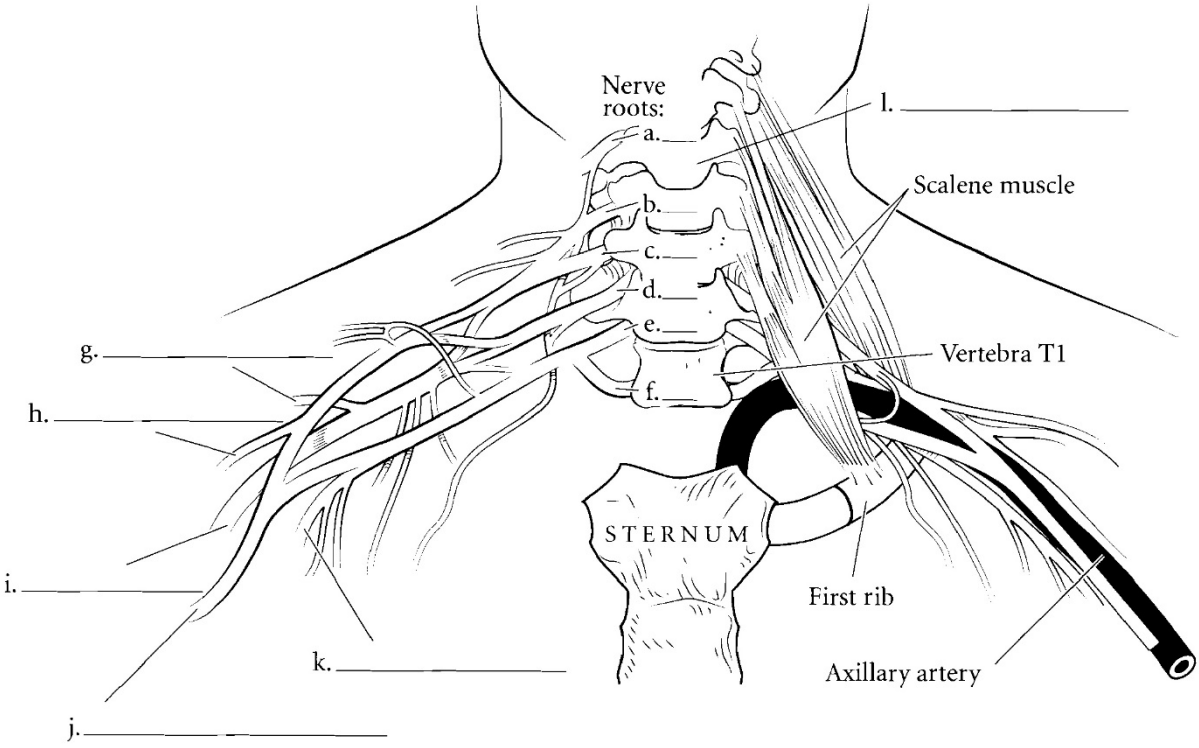
1. **Identify the muscles of the dorsal scapular region on the cadaver & plastic specimen.**
2. **Identify the dorsal scapular spaces and the structures passing through them.**
3. **Using red (for origin) and blue (for insertion), color the areas of the muscles attached to the scapula on the diagram below.**





The axilla & brachial plexus

1. **Review the muscles that form the walls of the axilla.**
2. **Identify the parts of the axillary artery and related anastomosis.**
3. **Using the diagram below, label the branches of the brachial plexus and give the root value of each.**



Review questions:

1. Branches from the upper trunk of the brachial plexus supply all these muscles, except:

A. subclavius B. teres minor C. supraspinatus D. infraspinatus

2. Branches from the roots of the brachial plexus supply all these muscles, except:

A. rhomboids B. serratus anterior C. latissimus dorsi D.levator scapulae

3. The muscle that divides the axillary artery into three parts is supplied from this part of the brachial plexus:

A. medial cord B. lateral cord C. posterior cord D. roots

4. One of the following nerve root values is correct:

A. Median nerve (C4-C8) B. Ulnar nerve (C7-T1)

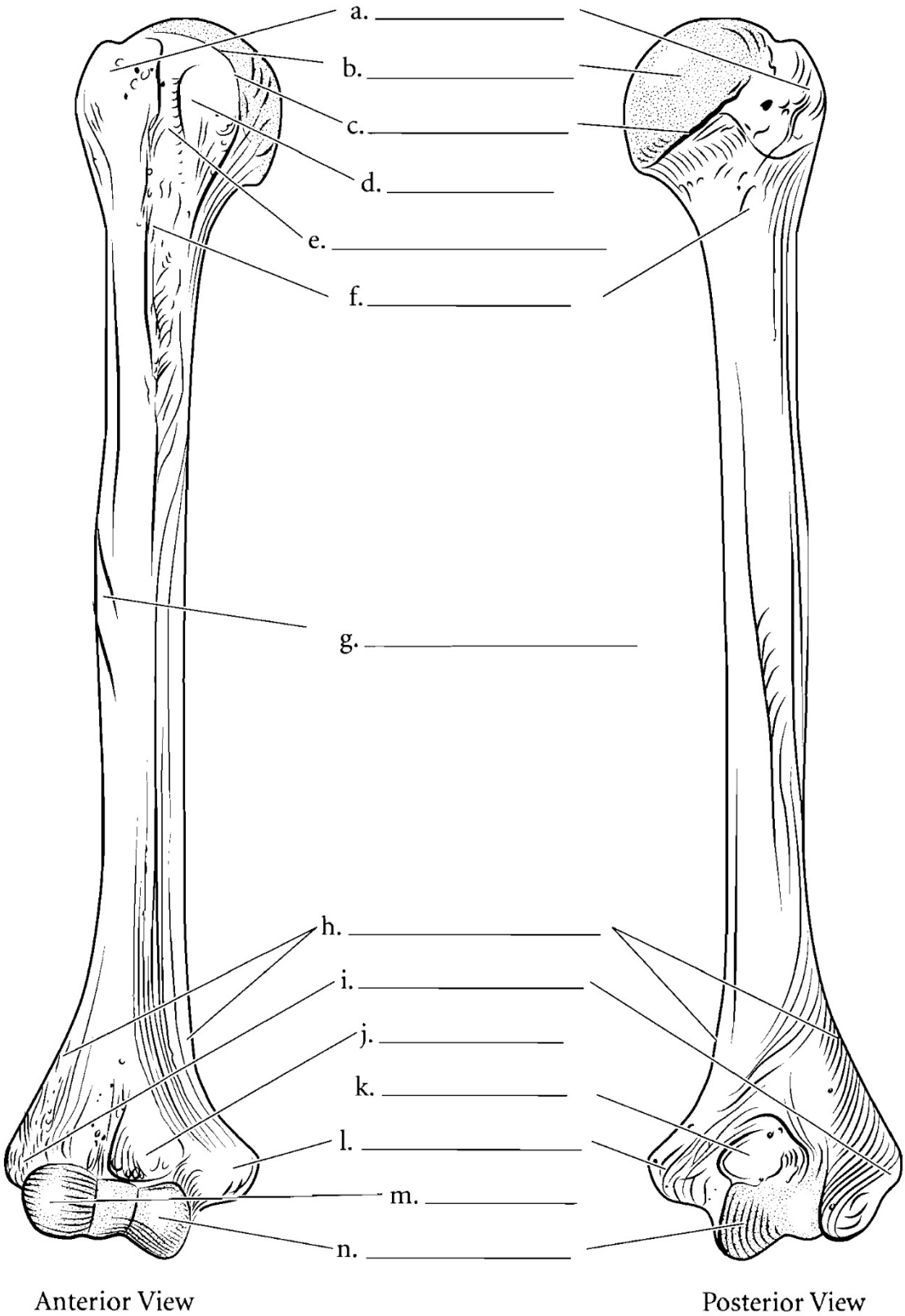
C. Musculocutaneous nerve (C6-C8) D. long thoracic nerve (C6-C8)

5. One of the following is a direct branch from the 3rd part of the axillary artery:

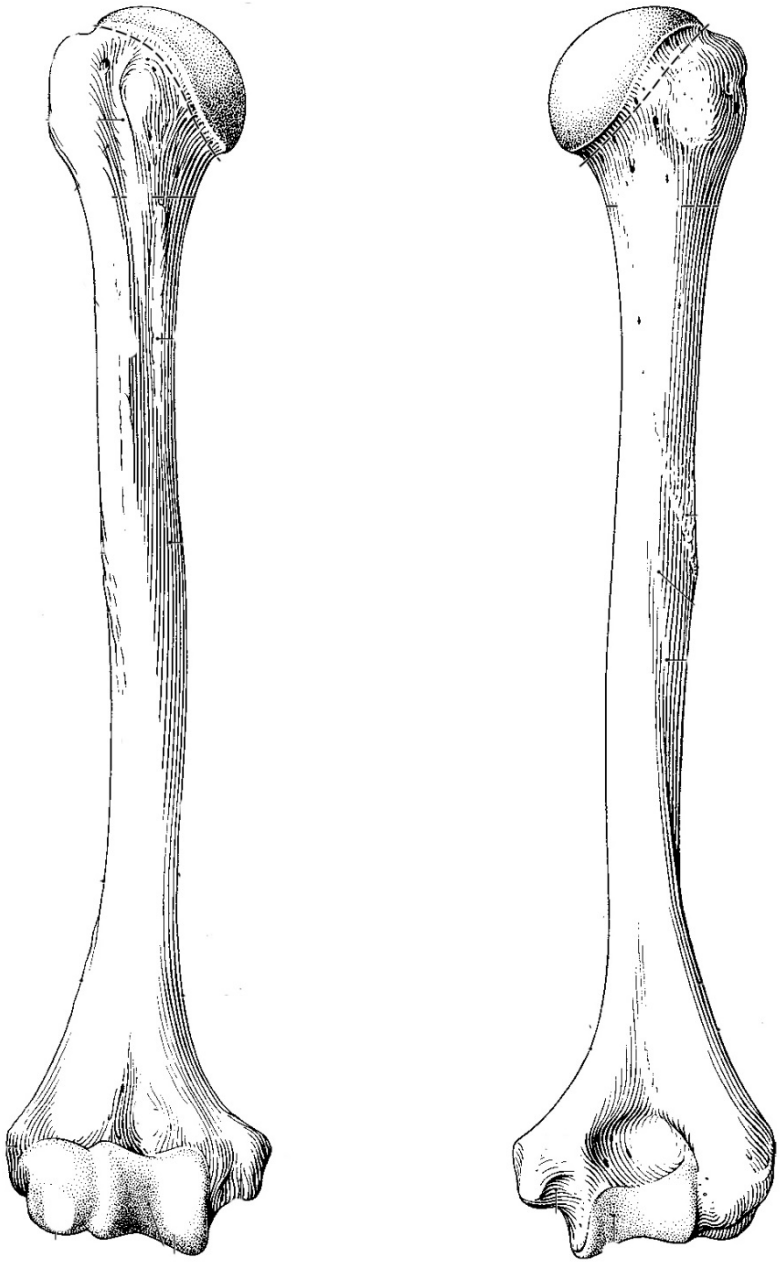
A. thoracodorsal B. subscapular C. circumflex scapular D. dorsal scapular

The arm

1. **Identify the osteological markings of the humerus on the fresh bone & diagram below and position the bone correctly on your body.**

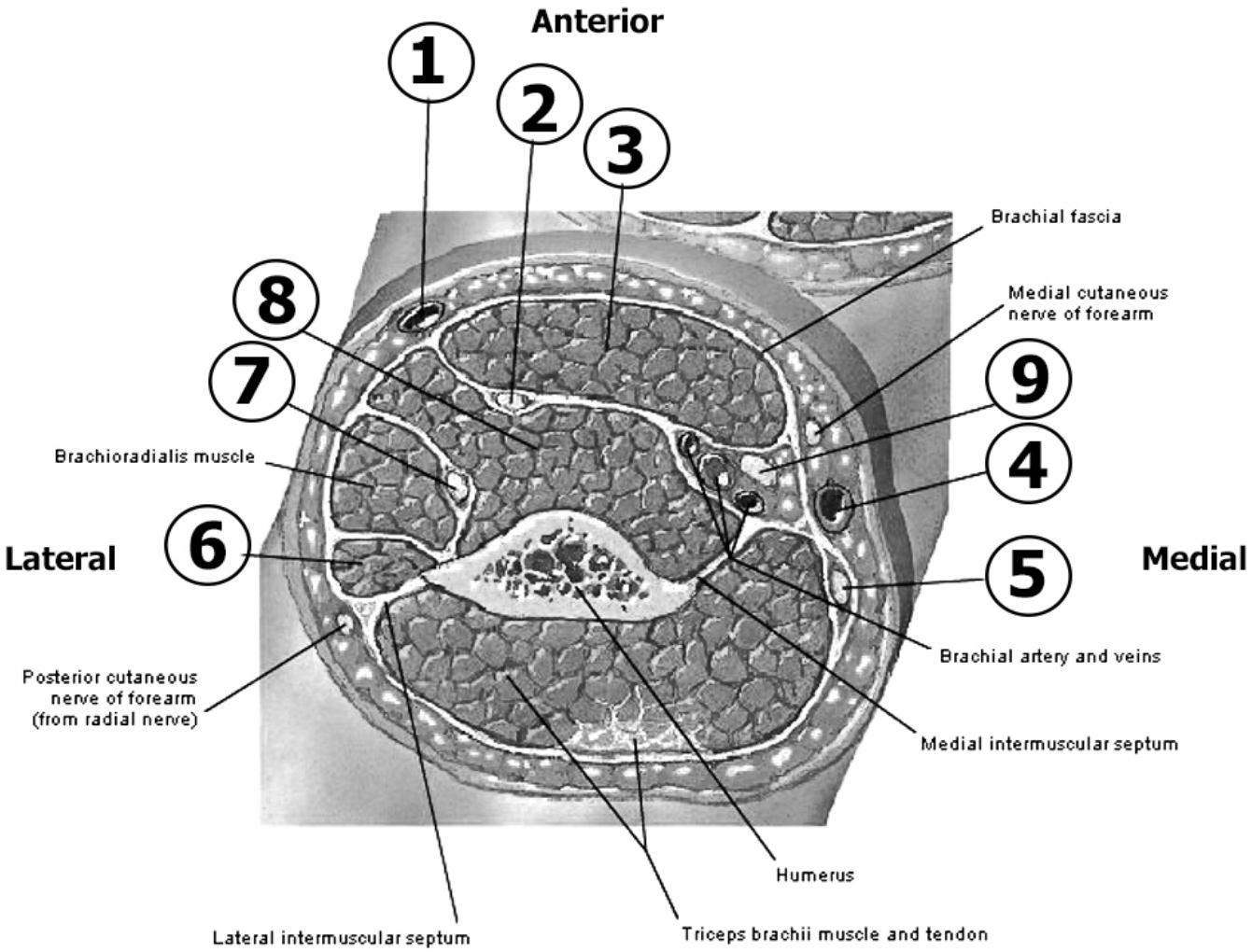


2. **Using the diagram below, color in red & blue the muscle attachments to the humerus.**



3. **Identify the muscles of the arm and the arrangement of its neurovascular bundle on the cadaver and plastic specimen.**

In relation to the diagram below which shows a cross section in the middle third of the arm.



1. One of the following is true:

A. Label 8 is a powerful supinator

B. Label 7 is the musculocutaneous nerve

C. Label 4 is normally larger than label 1

D. Label 6 extends the elbow

2. One of the following is a pure cutaneous nerve in this region:

A. 2 B. 5 C. 7 D. 9

3. One of the following is correct regarding the muscle under label 3:

A. its tendon lies lateral to the brachial artery

B. it inserts to the coronoid process

C. it is supplied by two nerves

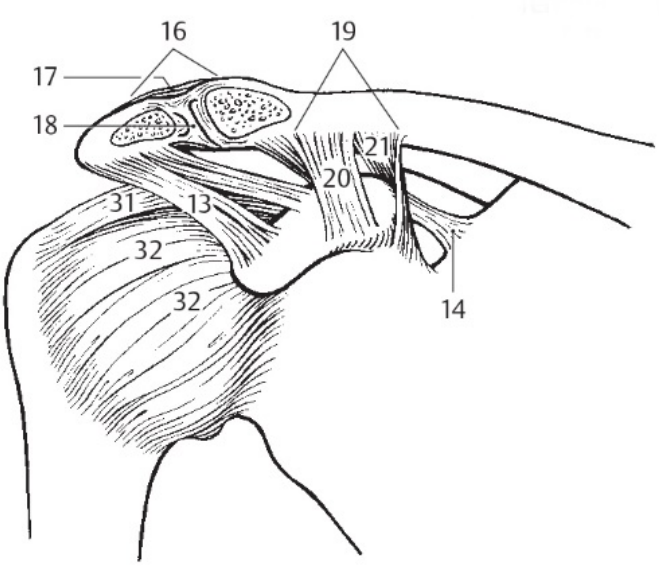
D. it takes origin from the humerus

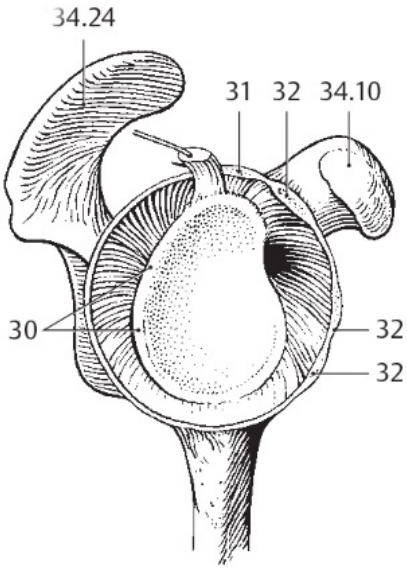
4. The structure that pierces the clavipectoral fascia is carrying label:

A. 1 B. 2 C. 4 D. 5

The shoulder joint

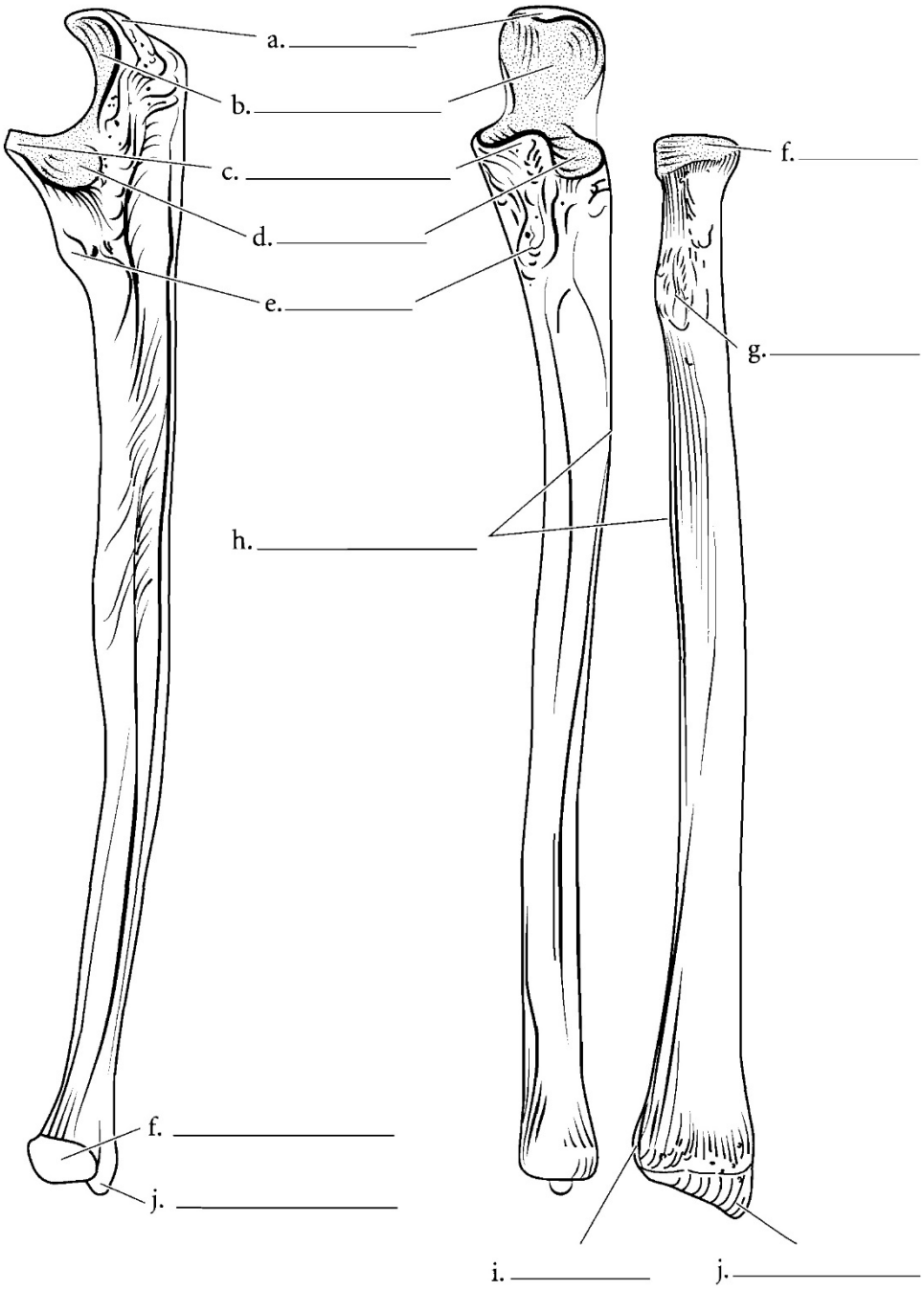
1. **Identify the ligaments and bursae of the shoulder joint on the plastic specimens.**
2. **Review the movements of the shoulder joint and the muscles producing them.**
3. **Complete the labeling of the diagram below.**

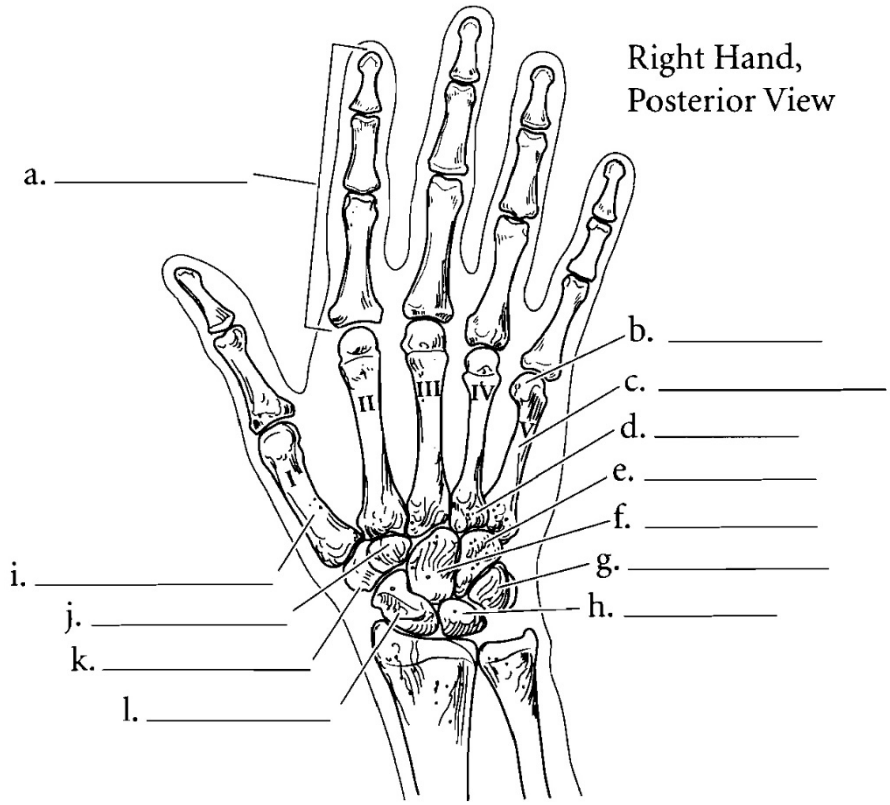


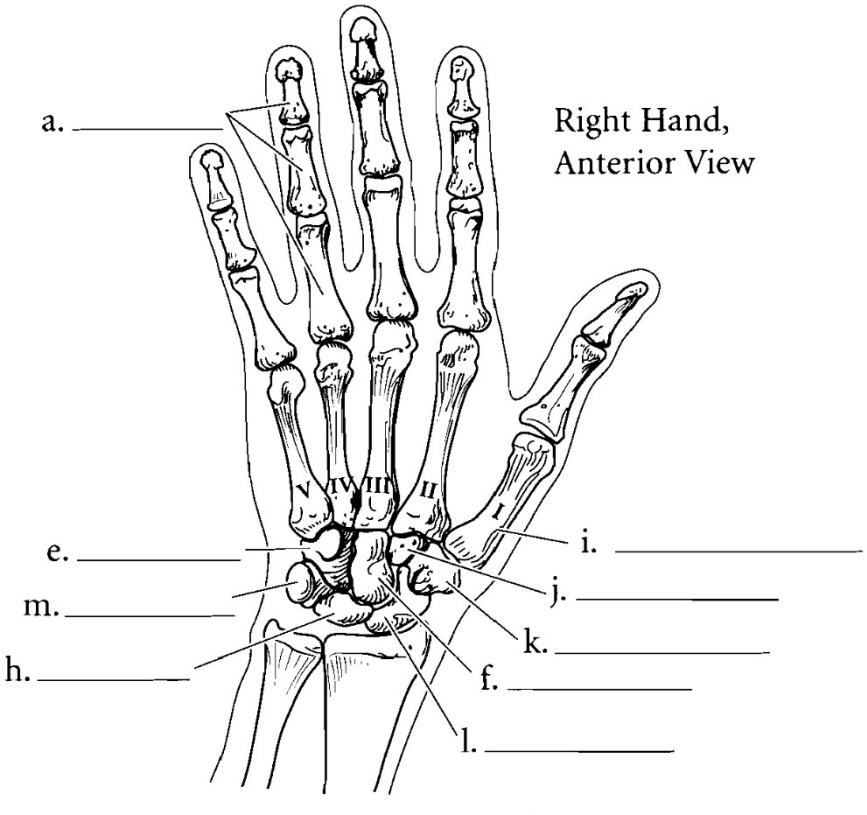


The cubital fossa & forearm

1. **On the cadaver and plastic specimen, identify the following:**
   - **The borders and floor of the cubital fossa (pronator teres, brachioradialis, brachialis, supinator).**
   - **The arrangement of contents (Median nerve, brachial artery, biceps tendon & aponeurosis, branching radial nerve).**
2. **Review the osteological features of the bones of the forearm and hand. on the diagrams below.**

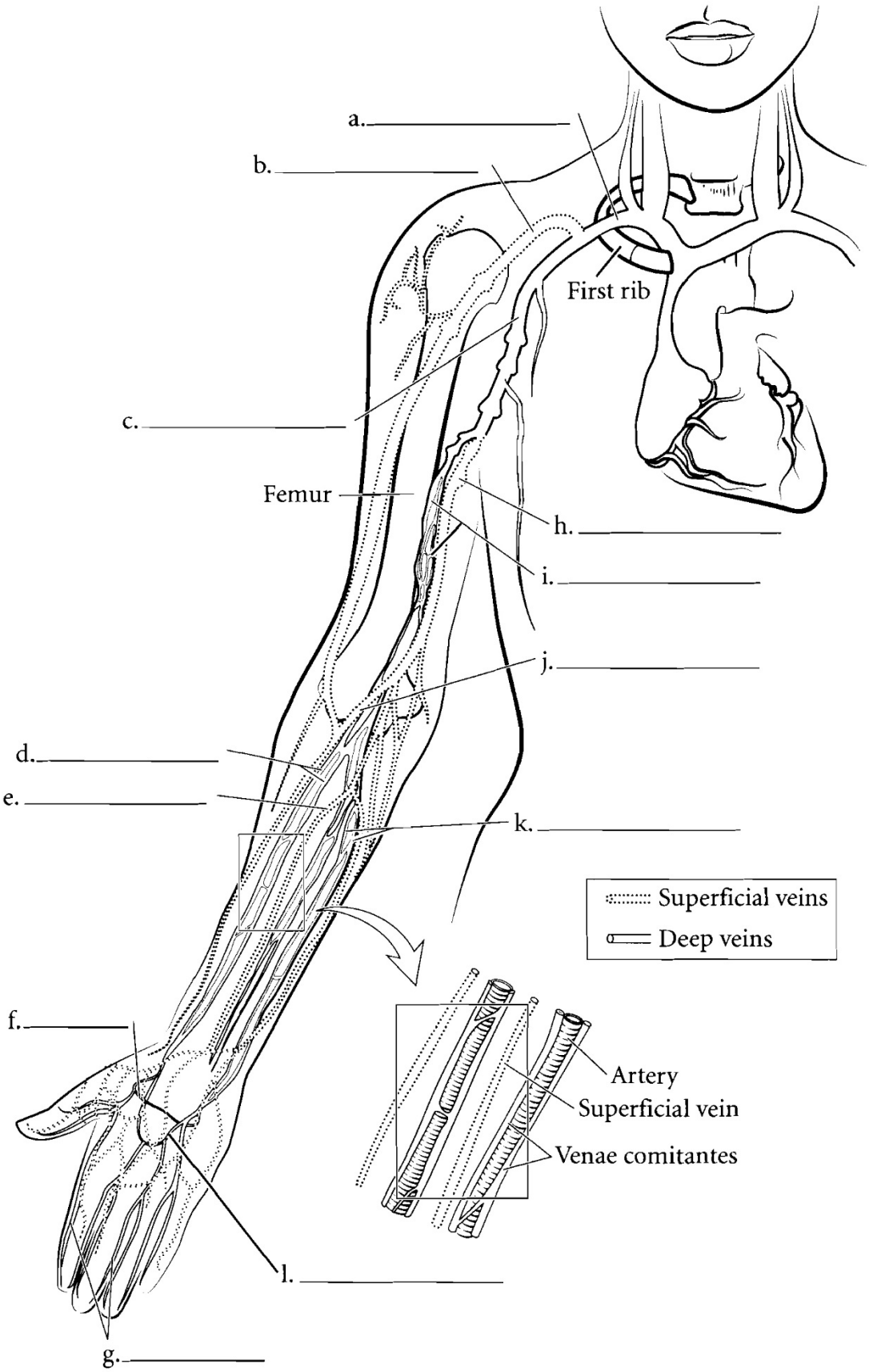






3. Review the cutaneous nerves and dermatomes of the upper limb.

4. Review the venous drainage of the upper limb using the diagram below.



Review questions:

1. Examining cutaneous sensation over the acromion examines this dermatome:

A. C4 B. C6 C. C8 D. T2

2. The most lateral carpal bone in the distal row is:

A. scaphoid B. trapezium C. trapezoid D. triquetral

3. One of the following muscles is supplied by the anterior interosseous nerve:

A. flexor carpi radialis B. flexor pollicis longus

C. flexor carpi ulnaris D. pronator teres

4. One of the following muscles belong to the superficial forearm extensors:

A. extensor digiti minimi B. extensor pollicis longus

B. extensor indicis D. abductor pollicis longus

5. In the forearm, one of the following is correct:

A. the interosseous artery arises as a branch from the radial artery.

B. the ulnar artery is lateral to the ulnar nerve.

C. the radial artery forms anastomosis on the medial side of the elbow

D. the anterior interosseous nerve ends in the posterior compartment.

6. The medial border of the anatomical snuff box is formed by the tendon of:

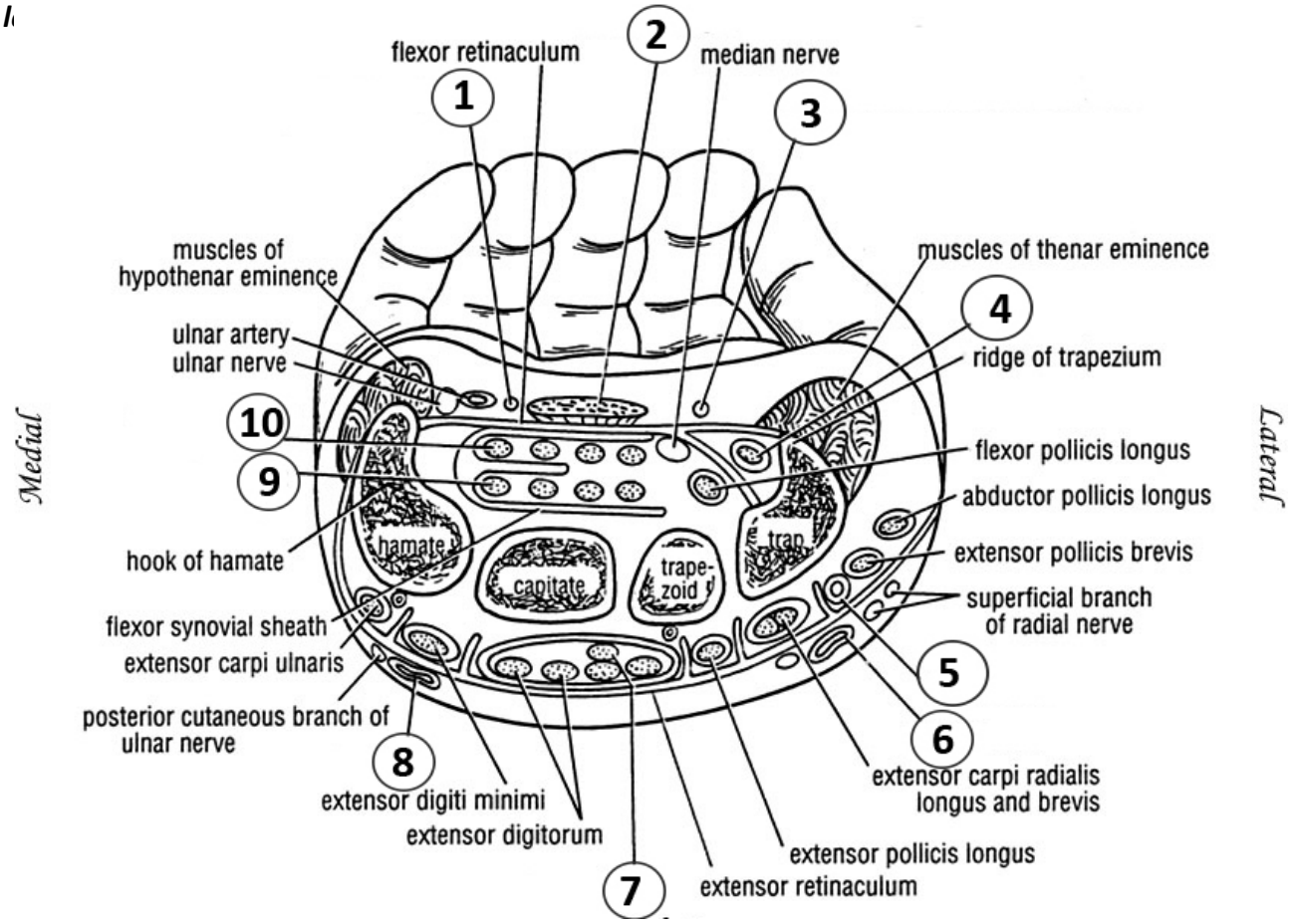
A. extensor pollicis longus B. extensor pollicis brevis

C. abductor pollicis longus D. abductor pollicis brevis

7. With the forearm in midpronation, elbow flexion is carried out by this muscle:

A. biceps brachii B. brachialis C. brachioradialis D. coracobrachialis

Questions 8 – 10 are related to the diagram below which shows a cross section of the wrist at the l



8. The tendons of this muscle flex the distal interphalangeal joints:

A. 4 B. 7 C. 9 D. 10

9. The nerve that supplies the skin of the lateral 2/3 of the palm is:

A. 1 B. 3 C. 5 D. 6

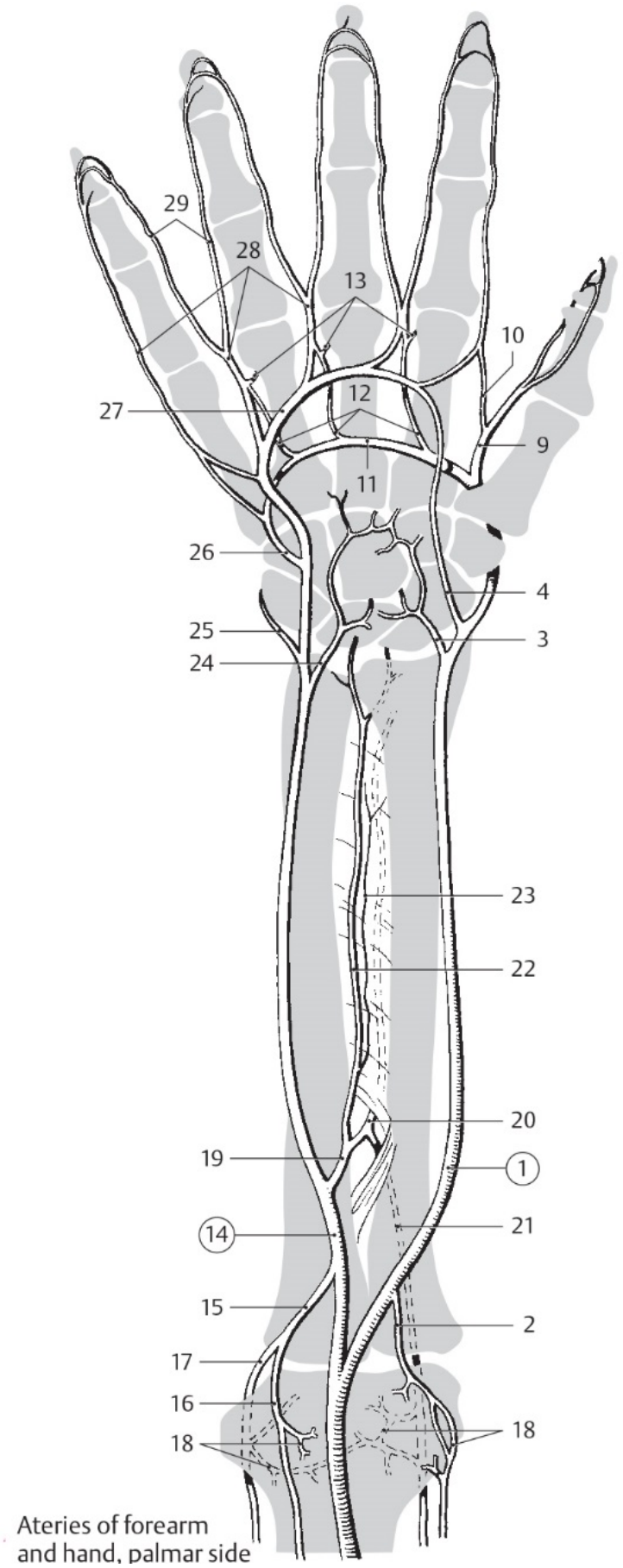
10. The tendon of label 4 is supplied by this nerve:

A. radial B. posterior interosseous C. median D. anterior interosseous

The hand

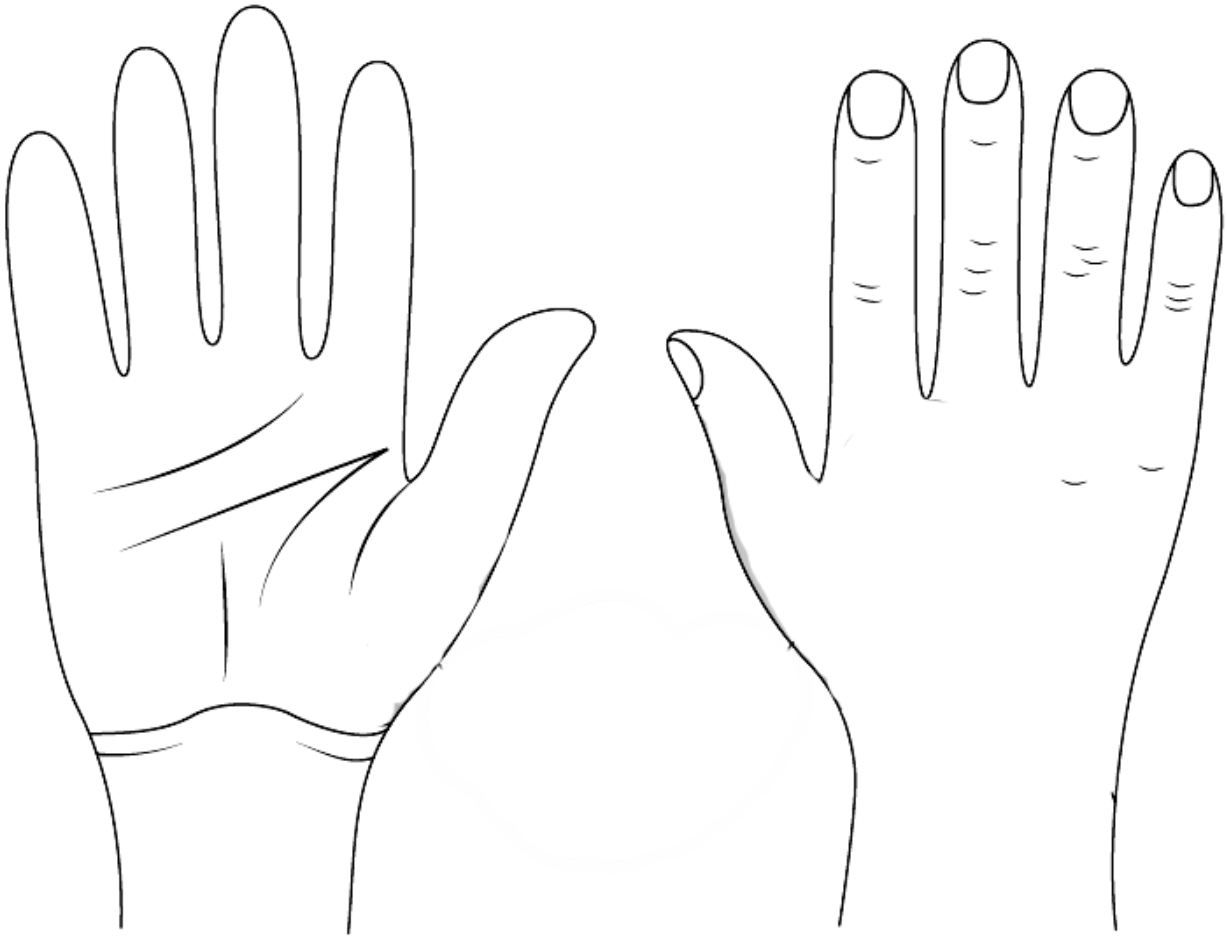
1. **Classify the muscles of the hand into intrinsic and extrinsic groups and give the subcategories of each group.**
2. **On the plastic specimens differentiate the following muscles:**
   - **Abductor pollicis brevis, flexor pollicis brevis, opponens pollicis & adductor pollicis.**
   - **Abductor digiti minimi, flexor digiti minimi & opponenes digiti minimi.**
   - **Palmaris brevis.**
   - **The lumbricals (How many are there? How many heads do they have?)**
   - **The palmar & dorsal interossei (Number? Position? Action?)**
3. **What is the function of the fibrous flexor sheaths and dorsal expansions?**

4. On the diagram below review the arterial supply of the forearm & hand.



Ateries of forearm and hand, palmar side

5. **On the diagram below, color the cutaneous areas of the hand? Are there variations in this arrangement?**



Review questions

1. The wrist joint is crossed laterally by the:

A. radial artery B. brachioradialis tendon C. median nerve D. basilic vein

2. This thumb muscle is supplied by median nerve:

A. Extensor pollicis longus B. extensor pollicis brevis

C. abductor pollicis longus D. abductor pollicis brevis

3. All the little finger muscles are supplied by the ulnar nerve, except:

A. flexor digiti minimi B. extensor digiti minimi

C. abductor digiti minimi D. opponens digiti minimi

4. The radial bursa surrounds the tendon of:

A. flexor carpi radialis B. flexor pollicis longus

C. extensor carpi radialis D. extensor pollicis longus

5. The central part of the dorsal expansion of the index is formed by the tendon of:

A. extensor indicis B. extensor digitorum

C. both A & B D. the lumbricals & interossei

6. Regarding the intrinsic muscles of the hand, one of the following is not true:

A. all the interossei are supplied by the ulnar nerve

B. all the thenar muscles are supplied by the median nerve except adductor pollicis

C. all the lumbricals are supplied by the ulnar nerve

D. all the hypothenar muscles are supplied by the ulnar nerve

7. The superficial arterial palmar arch:

A. is mainly formed by the radial artery. B. supplies the medial 3 ½ fingers

C. gives recurrent carpal branches D. lies anterior to the palmar aponeurosis

8. The nail bed of the index finger receives cutaneous branches from this nerve:

A. ulnar B. median C. superficial radial D. deep radial

9. A sharp glass penetrating the thenar space would probably injure this muscle:

A. flexor pollicis brevis B. abductor pollicis brevis C. opponens pollicis D. adductor pollicis

10. Regarding the small joints of the hand, one of the following is not true:

A. all the Intercarpal joints are plane joints

B. the interphalangeal joints are hinge joints

C. all the carpometacarpal joints are pane joints

D. the metacarpophalangeal joints can be flexed by the lumbricals