Upper Limb

The upper limb is a multijointed lever that is freely movable on the trunk at the shoulder joint. At its distal end is the important organ: the hand.
It is suggested that the upper limb be reviewed in the following order:
1. The **mammary gland.** Situated in the pectoral region, this organ is of great clinical importance.
2. A brief overview of the **bones** and the **major joints,** preferably with the help of an articulated skeleton.
3. A consideration of the more **important muscles,** with special emphasis on their actions and nerve supply.
4. A brief review of the **blood supply** and **lymphatic drainage** of the upper limb.
5. A detailed overview of the **nerves** and their distribution, with special emphasis on the branches of the brachial plexus (which are frequently injured).

MAMMARY GLAND

The mammary glands are specialized accessory glands of the skin that secrete milk and are present in both sexes. In males and immature females, the mammary glands are similar in structure. The **nipples** are small and surrounded by a colored area of skin called the **areola.** The breast tissue consists of a system of ducts embedded in connective tissue that does not extend beyond the margin of the areola.
Under the influence of the ovarian hormones, the mammary glands gradually enlarge and assume their hemispherical shape in females at puberty. The ducts elongate, but this increased size of the glands mainly results from the deposition of adipose tissue. The base of the breast extends from the second to the sixth rib and from the lateral margin of the sternum to the midaxillary line. The greater part of the gland lies in the superficial fascia, but a small part (the **axillary tail**) pierces the deep fascia at the lower border of the pectoralis major muscle and enters the axilla. The mammary glands are separated from the deep fascia covering the underlying muscle by loose areolar tissue called the **retromammary space.**
Each gland consists of 15 to 20 **lobes** that radiate outward from the nipple. There is nocapsule. Each lobe is separated from its neighbor by connective tissue septa that extend from the skin to the deep fascia and that serve as **suspensory ligaments.** The main **lactiferous duct** from each lobe opens separately on the summit of the nipple and possesses a dilated **ampulla** or **lactiferous sinus** just before its termination. The ampulla serves as a small reservoir for the secreted milk.

Blood Supply

(ARTERIES):Lateral thoracic and thoracoacromial arteries, branches of the axillary artery, and perforating branches of the internal thoracic and intercostal arteries supply the breast.
(VEINS):The veins correspond to the arteries.

Lymphatic Drainage

The lateral quadrants of the breast drain into the anterior axillary or the pectoral nodes. The medial quadrants drain into the internal thoracic nodes. A few lymph vessels also drain posteriorly into the posterior intercostal nodes, and some communicate with the lymphatic vessels of the opposite breast and with those of the anterior abdominal wall.

BONES

Bones of the Shoulder Girdle

The clavicle and the scapula form the shoulder girdle.

(CLAVICLE):The clavicle articulates medially with the sternum and the first costal cartilage and laterally with the scapula. The medial two thirds is convex forward, and the lateral one third is concave forward.

(SCAPULA):The scapula is a flat, triangular bone. On its posterior surface, the **spine of the scapula** projects backward. The lateral end of the spine forms the **acromion,** which articulates with the clavicle, and the superolateral angle of the scapula forms the **glenoid cavity,** which articulates with the head of the humerus. The **coracoid process** projects upward and forward, and it provides attachment for muscles and ligaments. Medial to the base of the coracoid process is the **suprascapular notch.** The **subscapular fossa** is the concave anterior surface of the scapula. The **supraspinous fossa** lies above the spine, and the **infraspinous fossa** lies below the spine on the posterior surface of the scapula.

Bones of the Arm

(HUMERUS):The **head** of the humerus lies at the upper end and forms approximately a third of a sphere, which articulates with theglenoid cavity of the scapula. Immediately below the head is the **anatomical neck.** Below the anatomic neck are the **greater** and the **lesser tuberosities,** which are separated from each other by the **bicipital groove.** Distal to the tuberosities is this **surgical neck,** which is a narrow region that is frequently fractured. The **deltoid tuberosity** is a roughened area approximately halfway down the lateral aspect of the shaft, and it is for the insertion of the deltoid muscle. Behind and below the deltoid tuberosity is a **spiral groove,** in which the radial nerve lies. The **medial** and the **lateral epicondyles** lie at the lower end of the humerus and are for the attachment of muscles and ligaments. The rounded **capitulum** articulates with the head of the radius, and the pulley-shaped **trochlea** articulates with the trochlear notch of the ulna. The **radial fossa** lies above the capitulum, and it receives the head of the radius in full flexion of the elbow joint. Above the trochlea anteriorly is the **coronoid fossa,** which receives the coronoid process of the ulna during full flexion of the elbow joint. Above the trochlea posteriorly is the **olecranon fossa,** which receives the olecranon process of the ulna when the elbow joint is extended.

Bones of the Forearm

(RADIUS):The radius is the lateral bone of the forearm. The **head,** which is small and circular, lies at the upper end. The upper concave surface articulates with the convex capitulum, and the circumference of the head articulates with the radial notch of the ulna. The bone is constricted below the head to form the **neck,** and below the neck is the **bicipital**

tuberosity, which is for the insertion of the biceps brachii muscle. Medially, the **shaft** has a sharp **interosseous border** for the attachment of the **interosseous membrane,** which binds the radius and the ulna together. The **styloid process** projects distally from the lateral margin of the lower end of the radius. On the medial surface of the lower end is the **ulnar notch,** which articulates with the head of the ulna. The inferior surface of the lower end articulates with the scaphoid and the lunate bones. On the posterior surface of the lower end is the small **dorsal tubercle,** which is grooved on its medial side by the tendon of extensor pollicis longus.

(ULNA):The ulna is the medial bone of the forearm. The **olecranon process** is the large upper end that forms the prominence of the elbow, and the **trochlear notch** lies on the anterior surface of the olecranon process and articulates with the trochlea of the humerus. Below the trochlear notch is the triangular **coronoid process,** which on its lateral surface has the radial notch for articulation with the head of the radius. Laterally, the **shaft** has a sharp **interosseous border** for the attachment of the interosseous membrane. The small, rounded **head** lies at the lower end of the ulna. The **styloid process** projects from the medial aspect of the head.

Bones of the Hand

(CARPAL BONES): There are eight carpal bones, which are arranged in two rows of four. From lateral to medial, the **proximal row** consists of the **scaphoid** (navicular), the **lunate,** the **triquetral,** and the **pisiform** bones. From lateral to medial, the **distal row** consists of the **trapezium,** the **trapezoid,** the **capitate,** and the **hamate** bones. The carpal bones are united with one another by strong ligaments. Together, the bones form a concavity on their anterior surface, to the lateral and the medial edges of which is attached a strong membranous band (the **flexor retinaculum**) that forms a bridge. This bridge and the carpal bones form the **carpal tunnel** for the passage of the median nerve and the long flexor tendons of the fingers.

(METACARPAL BONES):There are five metacarpal bones, each of which has a proximal **base,** a **shaft,** and a distal **head**. The bases of the metacarpal bones articulate with the distal row of the carpal bones. The heads, which form the knuckles, articulate with the proximal phalanges.

(PHALANGES):There are three phalanges for each finger, but there are only two for the thumb. Each phalanx has a proximal **base,** a **shaft,** and a distal **head.**

JOINTS

Shoulder Joint

ARTICULATION:-The shoulder joint consists of the rounded head of the humerus and the shallow glenoid cavity of the scapula covered with hyaline cartilage . The glenoid cavity is deepened by the fibrocartilaginous rim (the **glenoid labrum**).

TYPE:- This joint is a synovial ball-and-socket joint.

CAPSULE:-The capsule of the shoulder joint is thin and lax, and it allows for a wide range of movement. It is attached around the outside of the glenoid labrum and to the anatomic neck of the humerus. The capsule is strengthened by the tendons of the short muscles around the joint,

the subscapularis muscle anteriorly, the supraspinatus muscle superiorly, and the infraspinatus and teres minor muscles posteriorly. Collectively, these muscle tendons are called the **rotator cuff,** which plays an important role in stabilizing the shoulder joint.

LIGAMENTS:-

(Glenohumeral Ligaments): The glenohumeral ligaments are three bands that strengthen the anterior part of the capsule.

(Transverse Humeral Ligament): The transverse humeral ligament bridges the gap between the greater and the lesser tuberosities of the humerus. It holds the tendon of the long head of the biceps muscle in place.

(Coracohumeral Ligament): The coracohumeral ligament strengthens the capsule above, and it extends from the root of the coracoid process to the greater tuberosity of the humerus.

(Accessory Ligament): The **coracoacromial ligament** extends from the coracoids process to the acromion. It protects the superior aspect of the joint.

SYNOVIAL MEMBRANE:-The synovial membrane lines the capsule, surrounds the tendon of the biceps, and protrudes forward through the capsule to form a bursa beneath the subscapularis muscle.

NERVE SUPPLY:- Axillary and suprascapular nerves supply the joint.

MOVEMENTS:-The shoulder joint has a wide range of movement.

- **Flexion:** Anterior fibers of the deltoid, the pectoralis major, the biceps, and the coracobrachialis muscles.
- **Extension:** Posterior fibers of the deltoid, the latissimus dorsi, and the teres major muscles.
- **Abduction:** Middle fibers of the deltoid muscle, assisted by the supraspinatus muscle.
- **Adduction:** Pectoralis major, latissimus dorsi, teres major, and teres minor muscles.
- **Lateral rotation:** Infraspinatus, teres minor, and posterior fibers of deltoid muscles.
- **Medial rotation:** Subscapularis, latissimus dorsi, teres major, and anterior fibers of deltoid muscles.
- **Circumduction:** A combination of all the described movements.

STABILITY:-

The strength of the joint depends on the tone of the subscapularis, the supraspinatus, the infraspinatus, and the teres minor (tendons from the rotator cuff) muscles. The weakest part of the joint lies inferiorly, because there is little support there and the capsule is weakest in that area.

IMPORTANT RELATIONS:-

- Anteriorly: Brachial plexus and axillary vessels.
- Inferiorly: Axillary nerve and posterior circumflex humeral vessels (because they lie in the quadrangular space).

Elbow Joint

ARTICULATION:- The elbow joint consists of the trochlea and capitulum of the humerus with the trochlear notch of the ulna and the head of the radius.

TYPE:- The elbow is a synovial hinge joint.

CAPSULE:- The capsule encloses the joint.

LIGAMENTS:-
(Lateral Collateral Ligament): The lateral collateral ligament is triangular in shape. It is attached by its apex to the lateral epicondyle of the humerus and by its base to the superior margin of the anular ligament and the ulna.
(Medial Collateral Ligament): The medial collateral ligament is triangular in shape, and it is attached by its apex to the medial epicondyle of the humerus and by its base to the coronoid process and olecranon process of the ulna. It is closely related to the ulnar nerve.
IMPORTANT RELATIONS:-
• **Anteriorly:** Median nerve and brachial artery.
• **Medially:** Ulnar nerve as it passes behind the medial epicondyle of the humerus.

Superior Radioulnar Joint

ARTICULATION:- The superior radioulnar joint consists of the circumference of the head of the radius and the anular ligament and the radial notch of the ulna. The anular ligament forms a collar around the head of the radius.
SYNOVIAL MEMBRANE:- The synovial membrane lines the capsule and is continuous above with that of the elbow joint.
MOVEMENT:-
• **Pronation:** Pronator teres and pronator quadratus muscles. This movement rotates the hand medially so that the palm faces posteriorly and the thumb lies on the medial side.
• **Supination:** Biceps and supinator muscles. This movement returns the pronated hand to the anatomic position so that the palm faces anteriorly and the thumb lies on the lateral side. (Supination is more powerful than pronation.)

Inferior Radioulnar Joint

ARTICULATION:-The inferior radioulnar joint consists of the head of ulna and the ulnar notch of radius.
TYPE:- This is a synovial pivot joint.
CAPSULE AND LIGAMENTS:- The capsule encloses the joint and is strengthened by anterior and posterior ligaments.
ARTICULAR DISC:- The articular disc is triangular in shape and is composed of fibrocartilage. Its apex is attached to the base of the styloid process of the ulna, and its base is attached to the lower border of the ulnar notch of the radius. It binds the distal ends of the radius and the ulna together and shuts off the inferior radioulnar joint from the wrist joint.
SYNOVIAL MEMBRANE:- The synovial membrane lines the capsule and is continuous below with the synovial membrane of the superior radioulnar joint.
NERVE SUPPLY:- Median, ulnar, musculocutaneous, and radial nerves supply the joint.
MOVEMENT:-
• **Flexion:** Brachialis, biceps, brachioradialis, and pronator teres muscles.
• **Extension:** Triceps and anconeus muscles.
Rotary movements are made around a vertical axis at the superior and the inferior radioulnar joints. (See the movements for the superior radioulnar joint) .

Wrist Joint (Radiocarpal Joint)

ARTICULATION:- The wrist joint consists of the distal end of radius and the triangular cartilaginous articular disc above and the scaphoid, the lunate, and the triquetral bones below.
TYPE:- The wrist is a synovial condyloid joint.
CAPSULE:- The capsule encloses the joint.
LIGAMENTS:-
• Anterior and posterior ligaments: They strengthen the capsule.
• Medial ligament: It connects the styloid process of the ulna to the triquetral bone.
• Lateral ligament: It connects the styloid process of the radius to the scaphoid bone.
SYNOVIAL MEMBRANE:- The synovial membrane lines the capsule.
NERVE SUPPLY:- Anterior interosseous nerve from the median and the deep branches of the radial and the ulnar nerves supply the wrist joint.
MOVEMENT:-
Rotation is not possible, because the articular surfaces are ovoid in shape. This lack of rotation is compensated for by the movements of pronation and supination of the forearm.
• **Flexion:** Flexor carpi radialis, flexor carpi ulnaris, palmaris longus, flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus muscles.
• **Extension:** Extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris, extensor digitorum, extensor indicis, extensor digiti minimi, and extensor pollicis longus muscles.
• **Abduction:** Flexor carpi radialis, extensor carpi radialis longus and brevis, abductor pollicis longus, and extensor pollicis longus and brevis muscles.
• **Adduction:** Flexor and extensor carpi ulnaris muscles.
IMPORTANT RELATIONS:-
• Anteriorly: Median and ulnar nerves.
• Laterally: Radial artery.

Carpometacarpal Joints

The carpometacarpal joints are synovial gliding joints with **anterior, posterior,** and **interosseous ligaments**.

CARPOMETACARPAL JOINT OF THE THUMB

Articulation:- The carpometacarpal joint of the thumb occurs between the trapezium and the saddle-shaped base of the first metacarpal bone.
Type:- This is a synovial saddle joint (biaxial joint).
Movements:-
• **Flexion:** Flexor pollicis brevis and longus and opponens pollicis muscles.
• **Extension:** Extensor pollicis longus and brevis muscles.
• **Abduction:** Abductor pollicis longus and brevis muscles.
• **Adduction:** Adductor pollicis muscle.
• **Rotation** (as in opposition): Opponens pollicis muscle (which rotates the thumb medially).

Metacarpophalangeal Joints

ARTICULATION:- The metacarpophalangeal joint consists of the convex heads of the metacarpal bones and the concave bases of the proximal phalanges.
TYPE:- These joints are synovial condyloid joints.
LIGAMENTS:-
(Palmar Ligaments):The palmar ligaments are strong and contain fibrocartilage.
(Collateral Ligaments): The collateral ligaments are cordlike bands that join the head of the metacarpal bone to the base of the phalanx. The collateral ligaments are taut when the joint is in flexion, and they are lax when the joint is in extension. (Thus fingers can be abducted and adducted in extension) .
MOVEMENT:-
• **Flexion:** Lumbricals and interossei muscles, assisted by flexor digitorum superficialis and profundus muscles.
• **Extension:** Extensor digitorum, extensor indicis, and extensor digiti minimi muscles.
• **Abduction** (movement away from the midline of the third finger): dorsal interossei—that is, **DAB** (dorsal abduct).
• **Adduction** (movement toward the midline of the third finger): palmar interossei—that is, **PAD** (palmar adduct). In the metacarpophalangeal joint of the thumb, flexion is performed by the flexor pollicis longus and brevis muscles, and extension is performed by the extensor pollicis longus and brevis muscles. Abduction and adduction are performed at the carpometacarpal joint.

Interphalangeal Joints

The interphalangeal joints are synovial hinge joints with a structure similar to that of the metacarpophalangeal joints.

MUSCLES OF THE UPPER LIMB

Shoulder Region

The muscles connecting the upper limb to the vertebral column are shown in. The muscles connecting the upper limb to the thoracic wall are shown in, and the muscles connecting the scapula to the humerus.
AXILLA:- The axilla (or armpit) is a pyramid-shaped space between the upper part of the arm and the side of the chest. The upper end (or **apex**) is directed into the root of the neck, and it is bounded in front by the clavicle, behind by the upper border of the scapula, and medially by the outer border of the first rib. The lower end (or **base**) is bounded in front by the anterior axillary fold (formed by the lower border of the pectoralis major muscle), behind by the posterior axillary fold (formed by the tendon of latissimus dorsi and the teres major muscle), and medially by the chest wall. The axilla contains the principal vessels (axillary artery and vein) and nerves (brachial plexus and its branches) that supply the upper limb. The axilla also contains many lymph nodes.
Axillary Sheath:-The axillary sheath encloses the axillary vessels and the brachial plexus. It is continuous above in the neck with the prevertebral layer of deep cervical fascia.

ROTATOR CUFF:- The rotator cuff is the name given to the tendons of the subscapularis, the supraspinatus, the infraspinatus, and the teres minor muscles, which are fused to the underlying capsule of the shoulder joint. The cuff is important in stabilizing the shoulder joint. erally by the surgical neck of the humerus and medially by the long head of the triceps.
QUADRANGULAR SPACE:- The quadrangular space, located immediately below the shoulder joint, is bounded above by the subscapularis muscle and below by the teres major muscle.

Upper Arm

FASCIAL COMPARTMENTS OF THE UPPER ARM:-
The upper arm is enclosed in a sheath of deep fascia. Two fascial septa (one on the medial and one on the lateral side) extend from this sheath and are attached to the medial and the lateral borders of the humerus, respectively. By this means, the upper arm is divided into an anterior and a posterior fascial compartment, with each compartment having its own muscles, nerves, and arteries.

CUBITAL FOSSA
The cubital fossa is a skin depression that lies in front of the elbow and is triangular in shape. It is bounded **laterally** by the brachioradialis muscle and **medially** by the pronator teres muscle. The **base** of the triangle is formed by an imaginary line drawn between the two epicondyles of the humerus.
From medial to lateral, the cubital fossa contains the median nerve, the bifurcation of the brachial artery into the ulnar and the radial arteries, the tendon of the biceps muscle, and the radial nerve and its deep branch. Lying in the superficial fascia covering the cubital fossa are the **cephalic** and the **basilic veins** as well as their tributaries.

Forearm

FASCIAL COMPARTMENTS
The forearm is enclosed in a sheath of deep fascia, which is attached to the periosteum of the posterior subcutaneous border of the ulna. Together with the interosseous membrane and fibrous intermuscular septa, this fascial sheath divides the forearm into several compartments, with each compartment having its own muscles, nerves, and blood supply.

INTEROSSEOUS MEMBRANE
The interosseous membrane is a strong membrane that unites the shafts of the radius and the ulna. Because its fibers are taut, the forearm is most stable in the midprone position (position of function). The interosseous membrane provides attachment for the neighboring muscles.

Wrist

FLEXOR AND EXTENSOR RETINACULA
The retinacula are bands of deep fascia that hold the long flexor and extensor tendons in position at the wrist. The flexor retinaculum is attached medially to the pisiform bone and the hook of the hamate and laterally to the tubercle of the scaphoid and the trapezium. The extensor retinaculum is attached medially to the pisiform bone and the hook of the hamate and laterally to the distal end of the radius.

CARPAL TUNNEL

The bones of the hand and the flexor retinaculum form the carpal tunnel.

Hand

FIBROUS FLEXOR SHEATHS

The anterior surface of each finger from the metacarpal head to the base of the distal phalanx is provided with a strong, fibrous sheath that is attached to the sides of the phalanges. The sheath and the bones form a blind tunnel in which the long flexor tendons of the finger lie.

SYNOVIAL FLEXOR SHEATHS

In the hand, the tendons of the flexor digitorum superficialis and profundus muscles invaginate a common synovial sheath from the lateral side. The medial part of this common sheath extends distally without interruption on the tendons of the little fingers. The lateral part of the sheath stops abruptly on the middle of the palm, and the distal ends of the long flexor tendons of the index, the middle, and the ring fingers acquire **digital synovial sheaths** as they enter the fingers. The flexor pollicis longus tendon has its own synovial sheath that passes into the thumb. Thesesheaths allow the long tendons to move smoothly, with a minimum of friction, beneath the flexor retinaculum and the fibrous flexor sheaths.

PALMAR APONEUROSIS

In the palm, the deep fascia is greatly thickened to protect the underlying tendons, nerves, and blood vessels and is called the **palmar aponeurosis.** It is continuous proximally with the palmaris longus tendon, and it is attached to the flexor retinaculum. It is also continuous with the fasciae covering the thenar and the hypothenar eminences.

ARTERIES OF THE UPPER LIMB

Axillary Artery

The axillary artery begins at the lateral border of the first rib as a continuation of the subclavian artery, and at the lower border of the teres major muscle, it becomes the brachial artery. Throughout its course, the artery is related to the cords of the brachial plexus and their branches, and it is enclosed with them in the **axillary sheath**. The pectoralis minor muscle crosses in front of the artery and thus divides it (for purposes of description) into three parts:

- The lateral border of the first rib to the upper border of the pectoralis minor muscle.
- The portion that lies posterior to the pectoralis minor.
- The portion from the lower border of the pectoralis minor muscle to the lower border of the teres major muscle.

BRANCHES

The first part of the axillary artery gives off one branch. The second part gives off two branches, and the third part gives off three branches.

Branch of the First Part:-The **highest thoracic artery** is small and runs to the chest wall.

Branches of the Second Part:- The **thoracoacromial artery** immediately divides into four terminal branches. The **lateral thoracic artery** runs to the chest wall and, in females, supplies

the mammary gland.

Branches of the Third Part:- The **subscapular artery** runs along the lower border of the subscapularis muscle. The **anterior** and the **posterior circumflex humeral arteries** wind around the front and the back of the surgical neck of the humerus, respectively.

ARTERIAL ANASTOMOSIS AROUND THE SHOULDER JOINT

The suprascapular and the superficial cervical arteries, which are branches of the thyrocervical trunk from the first part of the subclavian artery, anastomose with the subscapular and the anterior and posterior circumflex humeral arteries, which are branches of the third part of the axillary artery.

Brachial Artery

The brachial artery begins at the lower border of the teres major muscle as a direct continuation of the axillary artery. It descends through the anterior compartment of the arm on the brachialis muscle, enters the cubital fossa, and then ends at the level of the neck of the radius by dividing into the radial and the ulnar arteries. The brachial artery is superficial and is overlapped from the lateral side by the coracobrachialis and the biceps. The median nerve crosses its middle part, and the bicipital aponeurosis crosses its lower part, which has the tendon of the biceps on its lateral side.

BRANCHES

- **Muscular branches.**
- **Nutrient artery** to the humerus.
- **Profunda artery,** which is a large branch that follows the radial nerve into the posterior compartment of the arm (in the spiral groove).
- **Superior ulnar collateral artery,** which follows the ulnar nerve.
- **Inferior ulnar collateral artery,** which takes part in the anastomosis around the elbow joint.

Radial Artery

The radial artery is the smaller of the two terminal branches of the brachial artery. It begins in the cubital fossa at the level of the neck of the radius, and it descends through the anterior and the lateral compartments of the forearm and lies superficially throughout most of its course. In the middle third of its course, the radial nerve lies on its lateral side. At the wrist, the artery winds backward around the lateral side of the carpus to the proximal end of the space between the first and second metacarpal bones, where it passes anteriorly into the palm between the two heads of the first dorsal interosseous muscle and joins the deep branch of the ulnar artery, thus forming the **deep palmar arch**. In the lower part of the forearm, the radial artery lies on the anterior surface of the radius and is covered only by skin and fascia. Here, the artery has the tendon of the brachioradialis on its lateral side and the tendon of the flexor carpi radialis on its medial side **(the site for taking a radial pulse).**

BRANCHES

- **Muscular branches.**
- **Recurrent branch,** which takes part in the arterial anastomosis around the elbow joint.
- **Superficial palmar branch,** which arises just above the wrist, enters the palm, and frequently joins the ulnar artery to form the **superficial palmar arch.**
- **First dorsal metacarpal artery,** which supplies the adjacent sides of the thumb and the index finger.
- **Arteria princeps pollicis,** which divides into two branches that supply the sides of the thumb.
- **Arteria radialis indicis,** which supplies the lateral sideof the index finger.

DEEP PALMAR ARCH

The deep palmar arch is deeply placed in the palm, and it extends from the proximal end of the space between the first and second metacarpal bones to the base of the fifth metacarpal bone. It is formed as a continuation of the radial artery, and it terminates by anastomosing with the deep branch of the ulnar artery.

Branches

- **Palmar.**
- **Metacarpal.**
- **Perforating.**
- **Recurrent.**

Ulnar Artery

The ulnar artery is the larger of the two terminal branches of the brachial artery. It begins in the cubital fossa at the level of the neck of the radius, and it descends through the anterior compartment of the forearm and enters the palm **in front of** the flexor retinaculum in company with the ulnar nerve. It ends by forming the superficial palmar arch, often anastomosing with the superficial palmar branch of the radial artery. In the upper part of its course, the ulnar artery lies deep to the flexor muscles. Below, it becomes superficial and lies between the tendons of the flexor carpi ulnaris and the tendons of the flexor digitorum superficialis. In front of the flexor retinaculum, it lies just lateral to the pisiform bone and is covered only by skin and fascia **(the site for taking an ulnar pulse).**

BRANCHES

- **Muscular branches.**
- **Recurrent branches,** which take part in the arterial anastomosis around the elbow joint.
- **Common interosseous artery,** which arises from the upper part of the ulnar artery and divides into the **anterior** and the **posterior interosseous arteries.** These arteries descend on the anterior and the posterior surfaces of the interosseous membrane, respectively.
- **Deep palmar branch,** which arises in front of the flexor retinaculum and joins the radial

artery to complete the deep palmar arch.

SUPERFICIAL PALMAR ARCH

The superficial palmar arch lies just beneath the palmar aponeurosis on the long flexor tendons. It is a continuation of the ulnar artery, and it is often completed on the lateral side by the superficial palmar branch of the radial artery.

Branches

Digital arteries supply the four medial fingers.

VEINS OF THE UPPER LIMB

The superficial veins of the upper limb lie in the superficial fascia and are of great clinical importance. The deep veins accompany the main arteries.

Superficial Veins

DORSAL VENOUS NETWORK

The dorsal venous network lies on the dorsum of the hand. It is drained on the lateral side by the cephalic vein and on the medial side by the basilic vein.

CEPHALIC VEIN

The cephalic vein arises from the lateral side of the dorsal venous network and ascends around the lateral border of the forearm. It ascends on the anterior aspect of the forearm and runs along the lateral border of the biceps in the arm. On reaching the interval between the deltoid and the pectoralis major muscles, the cephalic vein pierces the deep fascia and joins the axillary vein.

BASILIC VEIN

The basilic vein arises from the medial side of the dorsal venous network and ascends on the posterior surface of the forearm. Just below the elbow, it inclines forward to reach the cubital fossa. The vein then ascends medial to the biceps and pierces the deep fascia at approximately the middle of the arm, after which it joins the venae comitantes of the brachial artery to form the axillary vein.

MEDIAN CUBITAL VEIN

The median cubital vein connects the cephalic vein to the basilic vein. It lies superficial to the bicipital aponeurosis, which separates it from the brachial artery.

MEDIAN VEIN OF THE FOREARM

The median vein is a small vein that arises in the palm and ascends on the front of the forearm. It drains into the basilic or the median cubital vein or divides into two branches, one of which joins the basilic **(median basilica vein)** and one of which joins the cephalic **(median cephalic vein).**

Deep Veins

VENAE COMITANTES

The deep veins accompany the respective arteries as venae comitantes. The two venae comitantes of the brachial artery join the basilic vein to form the axillary vein.

AXILLARY VEIN

The axillary vein is formed by the union of the venae comitantes of the brachial artery with the basilic vein. It then ascends along the medial border of the axillary artery and becomes the subclavian vein at the outer border of the first rib. It receives tributaries that correspond to the branches of the axillary artery. It also receives the cephalic vein.

LYMPHATIC DRAINAGE OF THE UPPER LIMB

The **superficial lymph vessels** ascend the limb in the superficial fascia and accompany the superficial veins. The **deep lymph vessels** lie deep to the deep fascia and follow the deep arteries and veins. All lymph vessels of the upper limb ultimately drain into lymph nodes in the axilla.

Axillary Lymph Nodes

The axillary lymph nodes drain lymph vessels from the entire upper limb. In addition, they drain lymph vessels from the **lateral part of the breast** and superficial lymph vessels from the thoracoabdominal walls above the level of the umbilicus.

There are 20 to 30 of these lymph nodes, which are located as follows:

- **Anterior (pectoral) nodes** lie along the lower border of pectoralis minor and behind pectoralis major muscles. They receive lymph from the lateral part of the breast and the superficial vessels from the thoracoabdominal wall above the level of the umbilicus.
- **Posterior (subscapular) nodes** lie in front of the subscapularis muscle. They receive superficial lymph vessels from the back down as far as the level of the iliac crests.
- **Lateral nodes** lie along the axillary vein. They receive most of the lymph vessels from the upper limb (except the superficial lymph vessels draining the lateral side, described below in infraclavicular nodes).
- **Central nodes** lie in the center of the axilla. They receive lymph from the three previously described groups.
- **Infraclavicular (deltopectoral) nodes** are not strictly axillary nodes, because they are located outside the axilla. They lie in the interval between the deltoid and the pectoralis major muscles. They receive lymph from the superficial vessels of the lateral side of the hand, the forearm, and the arm; the lymph vessels accompany the cephalic vein.
- **Apical group nodes** lie at the apex of the axilla. They receive lymph from all other axillary nodes and drain into the subclavian trunk in the neck.

Supratrochlear (Cubital) Lymph Node

The supratrochlear lymph node lies in the superficial fascia in the cubital fossa close to the trochlea of the humerus. It receives lymph from the medial fingers, the medial part of the hand, and the medial side of the forearm. The efferent lymph vessels ascend to the lateral axillary lymph nodes.

NERVES OF THE UPPER LIMB

Brachial Plexus

The brachial plexus is formed by the union of the anterior rami of the fifth, sixth, seventh, and eighth cervical spinal nerves and the first thoracic spinal nerve. This plexus is divided into **roots, trunks, divisions,** and **cords.** The roots of the brachial plexus enter the base of the neck between the scalenus anterior and the scalenus medius muscles. The trunks and the divisions cross the posterior triangle of the neck, and the cords become arranged around the axillary artery in the axilla. Here, the brachial plexus and the axillary artery and vein are enclosed in the axillary sheath. The branches of the brachial plexus and their distribution are summarized in. For dermatomal charts for the anterior and the posterior surfaces of the body.

MUSCULOCUTANEOUS NERVE

The musculocutaneous nerve arises from the lateral cord of the brachial plexus (C5, 6, and 7). It pierces the coracobrachialis muscle and then descends between the biceps and the brachialis muscles. In the region of the elbow, it pierces the deep fascia and is distributed to the skin as the **lateral cutaneous nerve of the forearm.** The musculocutaneous nerve supplies the coracobrachialis, both heads of the biceps, and the greater part of the brachialis muscles.

MEDIAN NERVE

The median nerve arises from the medial and the lateral cords of the brachial plexus (C5, 6, 7, 8, and T1). It descends on the lateral side of the axillary and the brachial arteries. Halfway down the arm, it crosses the brachial artery to reach its medial side. The nerve then descends through the forearm between the two heads of the pronator teres and runs on the posterior surface of the flexor digitorum superficalis. At the wrist, it lies behind the tendon of the palmaris longus. The median nerve enters the palm by passing **behind** the flexor retinaculum and through the carpal tunnel.

Branches of the Median Nerve in the Forearm

- **Muscular branches:** Pronator teres, flexor carpi radialis, palmaris longus, and flexor digitorum superficialis muscles.
- **Articular branches:** Elbow joint.
- **Anterior interosseous nerve: Muscular branches** to flexor pollicis longus, pronator quadratus, and lateral half of the flexor digitorum profundus muscles. **Articular branches** to wrist and carpal joints.

• **Palmar branch:** Skin over the lateral part of the palm.

Branches of the Median Nerve in the Palm

• **Muscular branches:** Abductor pollicis brevis, flexor pollicis brevis, opponens pollicis, and the first and the second lumbrical muscles.

• **Cutaneous branches**: Palmar aspect of the lateral three and a half fingers and the distal half of the dorsal aspect of each finger as well.

ULNAR NERVE

The ulnar nerve arises from the medial cord of the brachial plexus (C8, T1). It descends along the medial side of the axillary and the brachial arteries in the anterior compartment of the arm. At the middle of the arm, it pierces the medial intermuscular septum and passes down **behind** the medial epicondyle of the humerus. It then enters the anterior compartment of the forearm and descends behind the flexor carpi ulnaris medial to the ulnar artery. At the wrist, it passes **anterior** to the flexor retinaculum and **lateral** to the **pisiform bone.** It then divides into the **superficial** and the **deep terminal branches.**

Branches of the Ulnar Nerve in the Forearm

• **Muscular branches:** Flexor carpi ulnaris and medial half of the flexor digitorum profundus muscles.

• **Articular branches:** Elbow joint.

• **Dorsal cutaneous branch:** Supplies the skin over the medial side of the back of the hand and back of the medial one and a half fingers over the proximal phalanges.

Branches of the Ulnar Nerve in the Hand

The **superficial terminal branch** descends into the palm and gives off the following branches:

• **Muscular branch:** Palmaris brevis muscle.

• **Cutaneous branches:** Supply the skin over the palmar aspect of the medial one and a half fingers (including their nail beds). The **deep terminal branch** runs backward between the abductor digiti minimi and the flexor digiti minimi muscles, pierces the opponens digiti minimi muscle, and gives off the following branches:

• **Muscular branches:** Abductor digiti minimi, flexor digiti minimi, opponens digiti minimi, all palmar and all dorsal interossei, third and fourth lumbricals, and adductor pollicis muscles.

• **Articular branches:** Carpal joints.

RADIAL NERVE

The radial nerve arises from the posterior cord of the brachial plexus (C5, 6, 7, 8, and T1). It descends behind the axillary and the brachial arteries, and it enters the posterior compartment of the arm. The radial nerve winds around the back of the humerus in the spiral groove with the profunda artery. Piercing the lateral intermuscular septum just above the elbow, it descends in front of the lateral epicondyle and divides into the superficial and the deep

terminal branches.

Branches of the Radial Nerve in the Axilla

• **Muscular branches:** Long and medial heads of the triceps muscle.
• **Cutaneous branch:** Posterior cutaneous nerve of the arm.

Branches of the Radial Nerve in the Spiral Groove Behind the Humerus

• **Muscular branches:** Lateral and medial heads of the triceps muscle and the anconeus muscle.
• **Cutaneous branches:** Lower lateral cutaneous nerve of the arm, posterior cutaneous nerve of the forearm.

Branches of the Radial Nerve in the Anterior Compartment of the Arm Close to the Lateral Epicondyle

• **Muscular branches:** Brachialis, brachioradialis, and extensor carpi radialis longus muscles.
• **Articular branches:** Elbow joint.

Superficial Branch of Radial Nerve

The superficial branch of the radial nerve descends under cover of the brachioradialis muscle on the lateral side of the radial artery. It emerges from beneath the brachioradialis tendon and then descends on the back of the hand.

Cutaneous Branches

Cutaneous branches run to the lateral two thirds of the dorsal surface of the hand (variable). These branches also run to the posterior surface of the lateral three and a half fingers over the proximal phalanges.

Deep Branch of the Radial Nerve

The deep branch of the radial nerve winds around the lateral side of the neck of the radius within the supinator muscle. It enters the posterior compartment of the forearm, and it descends between the muscles. It gives off the following branches:

• **Muscular branches:** Extensor carpi radialis brevis, supinator, extensor carpi ulnaris, abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, and extensor indicis muscles.
• **Articular branches:** Wrist and carpal joints.

AXILLARY NERVE

The axillary nerve arises from the posterior cord of the brachial plexus (C5 and 6). It passes backward through the quadrangular space below the shoulder joint with the posterior circumflex humeral vessels.

Branches

• **Articular branch,** which supplies the shoulder joint.
• **Anterior terminal branch,** which winds around the surgical neck of the humerus and supplies the deltoid muscle and the skin that covers its lower half. (Supraclavicular nerves

supply the skin over the upper half of the deltoid muscle.)

• **Posterior terminal branch,** which supplies the teres minor and the deltoid muscles and then becomes the **upper lateral cutaneous nerve of the arm,** which also supplies the skin over the lower part of the deltoid muscle.

Upper Trunk Lesions of the Brachial Plexus (Erb-Duchenne Palsy)

Upper trunk lesions of the brachial plexus result from displacement of the head to the opposite side and depression of the shoulder on the same side, as during falls on the shoulder or in infants during a difficult delivery. The limb hangs limply by the side and is medially rotated, and the forearm is pronated (**waiter's tip hand**).

Lower Trunk Lesions of the Brachial Plexus (Klumpke Palsy)

Lower trunk lesions of the brachial plexus result from traction injury, as in excessive abduction of the arm. The first thoracic nerve is usually torn, all the small muscles of the hand are paralyzed, and the patient develops a **claw hand.**

Long Thoracic Nerve (C5, 6, and 7)

Lesions

Long thoracic nerve lesions result from blows or surgical injury to the nerve in the axilla. Paralysis of the serratus anterior muscle allows the inferior angle of the scapula to protrude **(winged scapula).** The patient also has difficulty in raising the arm above the head.

Axillary Nerve (C5 and 6) Lesions

Axillary nerve lesions result from inferior dislocations of the shoulder joint or fracture of the surgical neck of the humerus. Nerve damage occurs in the quadrangular space. The deltoid muscle is paralyzed and rapidly atrophies, and cutaneous sensation is lost over the lower half of the deltoid muscle.

Radial Nerve (C5, 6, 7, 8, and T1) Lesions

Radial nerve lesions commonly result from fracture of the midshaft of the humerus, which injures the nerve in the spiral groove. The patient is unable to extend the wrist and the fingers, and there is **wrist drop.**

Median Nerve (C5, 6, 7, 8, and T1) Lesions

Median nerve lesions commonly result from supracondylar fractures of the humerus and from wounds just proximal to the flexor retinaculum. Among the clinical signs, the muscles of the thenar eminence are paralyzed and wasted so that the eminence is flattened and the thumb is laterally rotated and adducted. The hand looks **apelike.**

ULNAR NERVE (C8 AND T1) LESIONS

Ulnar nerve lesions result from injuries where the nerve lies behind the medial epicondyle of the humerus and where it lies in front of the flexor retinaculum at the wrist. The small muscles

of the hand will be paralyzed except for the muscles of the thenar eminence and the first two lumbricals (median nerve). The patient is unable to adduct and abduct the fingers. In addition, the thumb cannot be adducted, because the adductor pollicis is paralyzed.
The metacarpophalangeal joints become hyperextended from paralysis of the lumbrical and the interosseous muscles, and thisis most prominent in the joints of the fourth and the fifth fingers. The interphalangeal joints are flexed (also from paralysis of the lumbrical and the interosseous muscles). In longstanding cases, the hand assumes the characteristic **claw deformity.**