

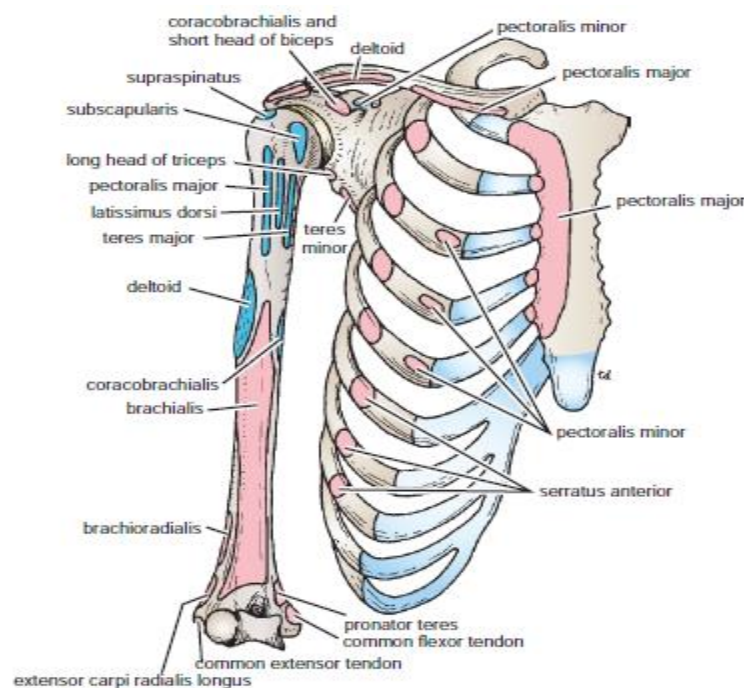
# The Upper Limbs

## **Basic Anatomy**

The upper limb is a multijointed lever that is freely movable on the trunk at the shoulder joint. At the distal end of the upper limb is the important organ, the hand. Much of the importance of the hand depends on the pincer-like action of the thumb, which enables one to grasp objects between the thumb and index finger. The upper limb is divided into the shoulder (junction of the trunk with the arm), arm, elbow, forearm, wrist, and hand.

## **Bones of the Shoulder Girdle and Arm**

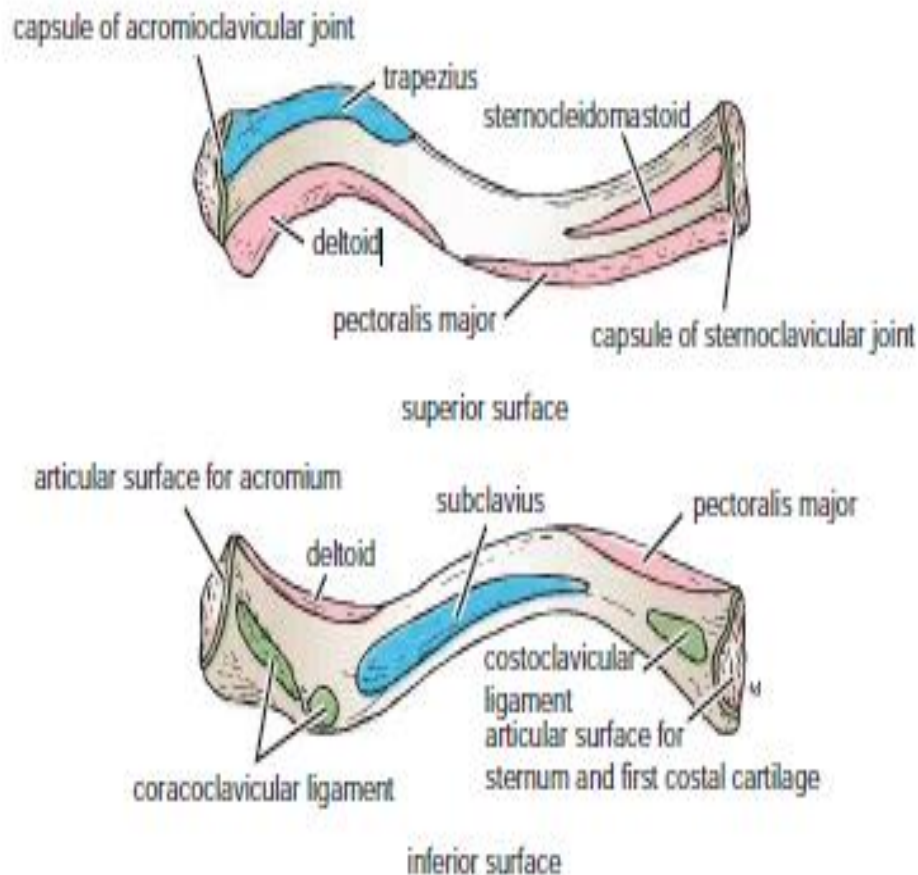
The shoulder girdle consists of the clavicle and the scapula, which articulate with one another at the acromioclavicular joint.



Muscle attachments to the bones of the thorax, clavicle, scapula, and humerus.

## **Clavicle**

The clavicle is a long, slender bone that lies horizontally across the root of the neck just beneath the skin. It articulates with the sternum and 1st costal cartilage medially and with the acromion process of the scapula laterally. The clavicle acts as a strut that holds the arm away from the trunk. It also transmits forces from the upper limb to the axial skeleton and provides attachment for muscles. The medial two thirds of the clavicle is convex forward and its lateral third is concave forward.

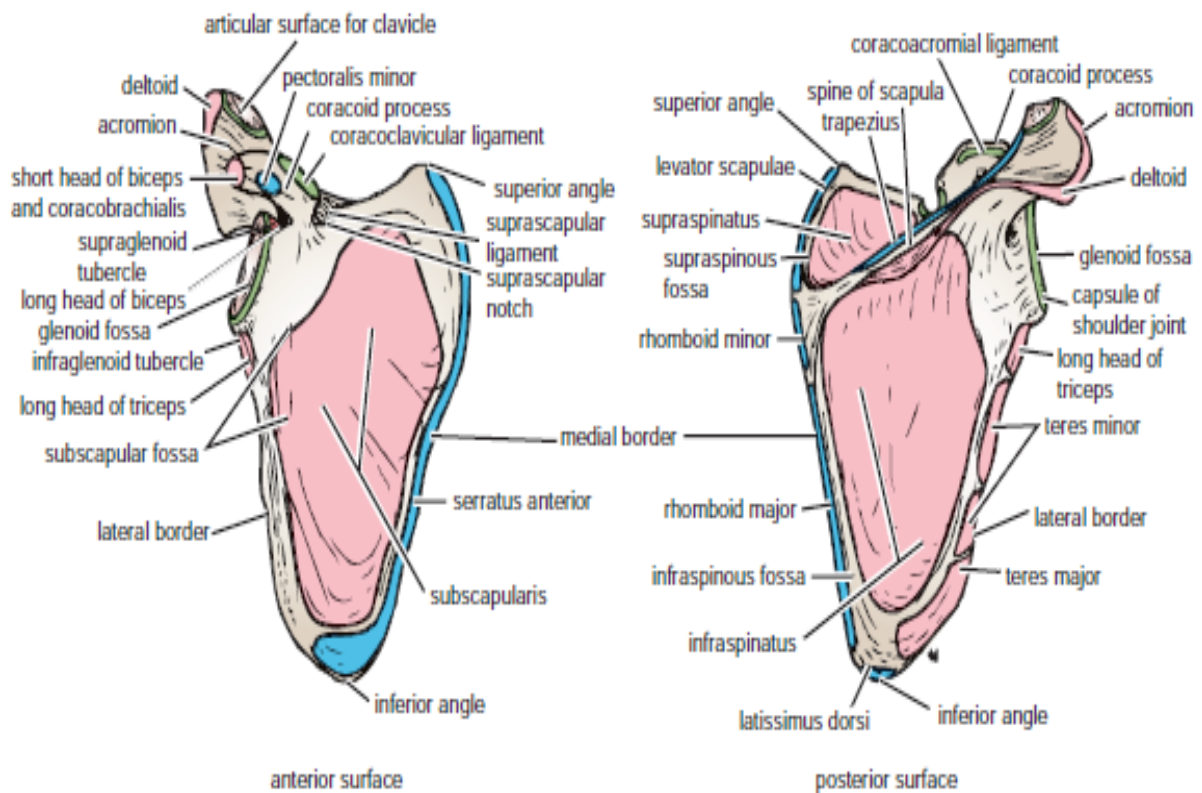


Important muscular and ligamentous attachments to the right clavicle.

## Scapula

The scapula is a flat triangular bone that lies on the posterior chest wall between the 2nd and 7th ribs. On its posterior surface, the spine of the scapula projects backward. The lateral end of the spine is free and forms the acromion, which articulates with the clavicle. The superolateral angle of the scapula forms the pear-shaped glenoid cavity, or fossa, which articulates with the head of the humerus at the shoulder joint. The coracoid process projects upward and forward above the glenoid cavity and provides attachment for muscles and ligaments. Medial to the base of the coracoid process is the suprascapular notch.

The anterior surface of the scapula is concave and forms the shallow subscapular fossa. The posterior surface of the scapula is divided by the spine into the supraspinous fossa above and an infraspinous fossa below. The inferior angle of the scapula can be palpated easily in the living subject and marks the level of the 7th rib and the spine of the 7th thoracic vertebra.

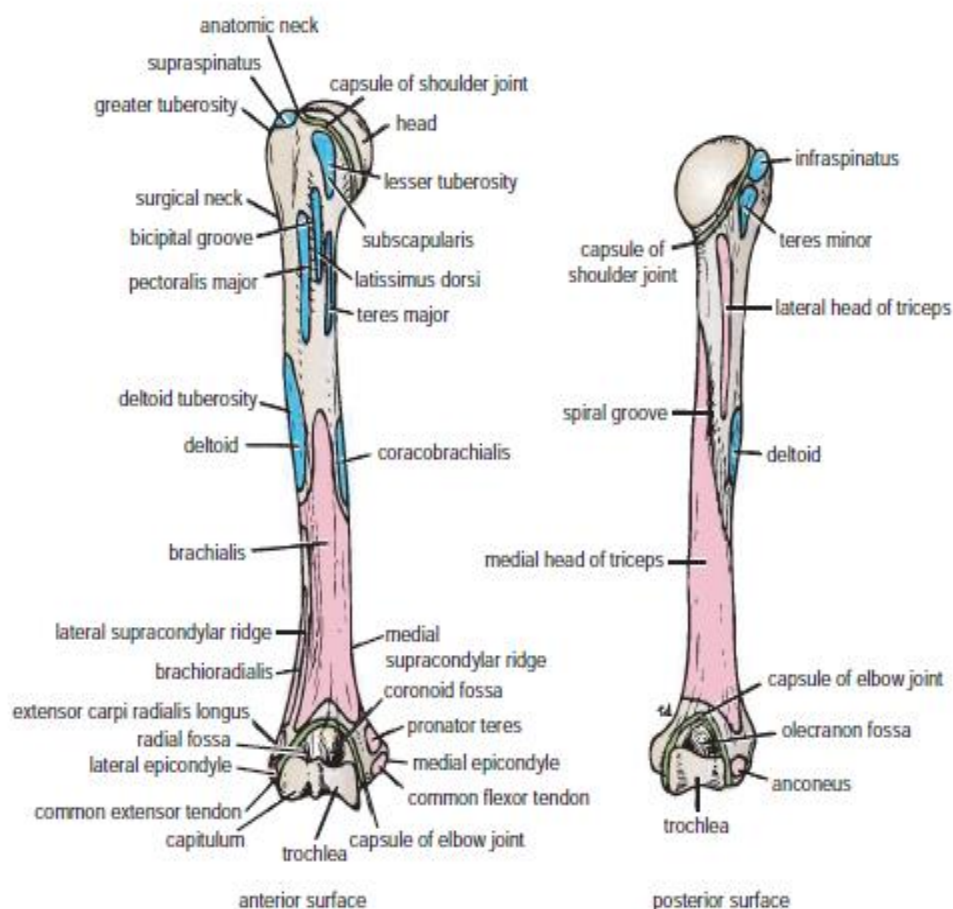


Important muscular and ligamentous attachments to the right scapula.

## Humerus

The humerus articulates with the scapula at the shoulder joint and with the radius and ulna at the elbow joint. The upper end of the humerus has a **head**, which forms about one third of a sphere and articulates with the glenoid cavity of the scapula. Immediately below the head is the **anatomic neck**. Below the neck are the **greater** and **lesser tuberosities**, separated from each other by the **bicipital groove**. Where the upper end of the humerus joins the shaft is a narrow **surgical neck**. The lower end of the humerus possesses the **medial** and **lateral epicondyles** for the attachment of muscles and ligaments, the rounded **capitulum** for articulation with the head of the radius, and the pulley-shaped **trochlea** for articulation with the trochlear notch of the ulna.

Above the capitulum is the **radial fossa**, which receives the head of the radius when the elbow is flexed. Above the trochlea anteriorly is the **coronoid fossa**, which during the same movement receives the coronoid process of the ulna. Above the trochlea posteriorly is the **olecranon fossa**, which receives the olecranon process of the ulna when the elbow joint is extended.



Important muscular and ligamentous attachments to the right humerus

## **The Axilla**

The axilla, or armpit, is a pyramid-shaped space between the upper part of the arm and the side of the chest. It forms an important passage for nerves, blood, and lymph vessels as they travel from the root of the neck to the upper limb. The upper end of the axilla, or **apex**, is directed into the root of the neck and 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.

### **Walls of the Axilla**

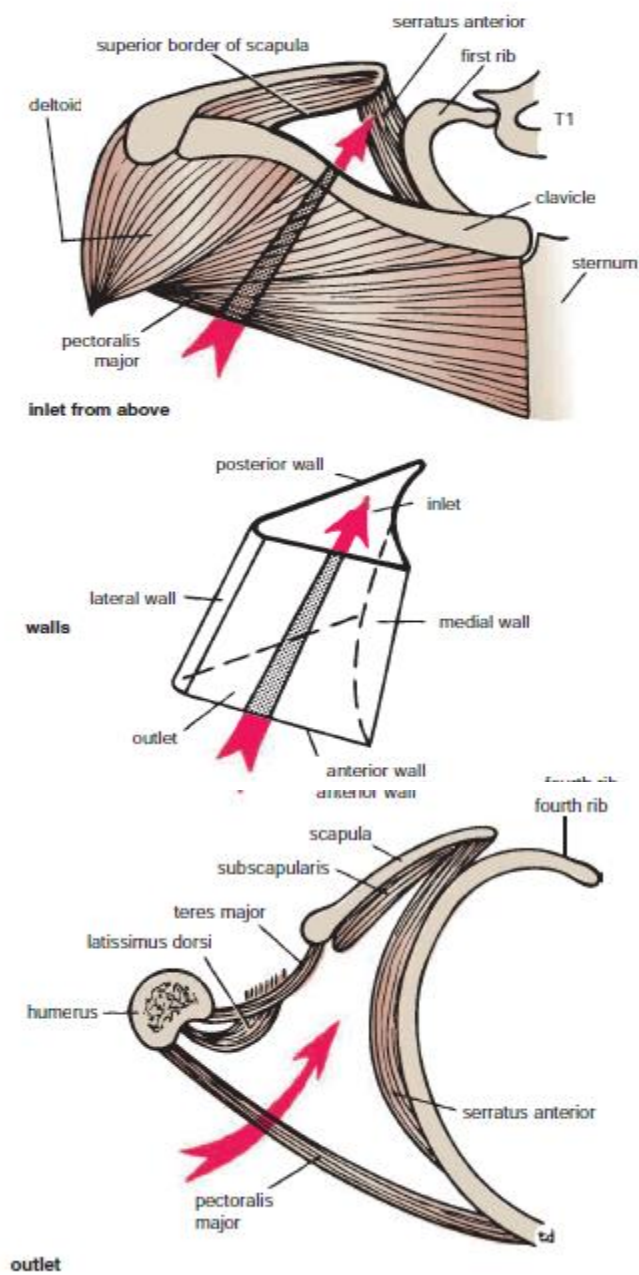
The walls of the axilla are made up as follows:

- **Anterior wall:** By the pectoralis major, subclavius, and pectoralis minor muscles
- **Posterior wall:** By the subscapularis, latissimus dorsi, and teres major muscles from above down
- **Medial wall:** By the upper four or five ribs and the intercostal spaces covered by the serratus anterior muscle.
- **Lateral wall:** By the coracobrachialis and biceps muscles in the bicipital groove of the humerus.

The **base** is formed by the skin stretching between the anterior and posterior walls. The axilla contains the principal vessels and nerves to the upper limb and many lymph nodes.

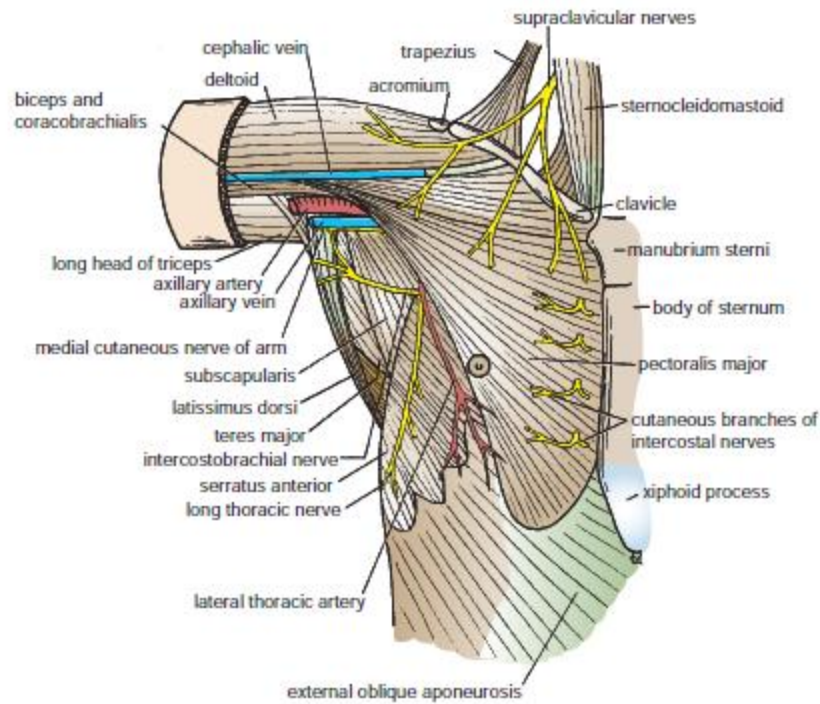
### **Contents of the Axilla**

The axilla contains the axillary artery and its branches, which supply blood to the upper limb; the axillary vein and its tributaries, which drain blood from the upper limb; and lymph vessels and lymph nodes, which drain lymph from the upper limb and the breast and from the skin of the trunk, down as far as the level of the umbilicus. Lying among these structures in the axilla is an important nerve plexus, the brachial plexus, which innervates the upper limb. These structures are embedded in fat.

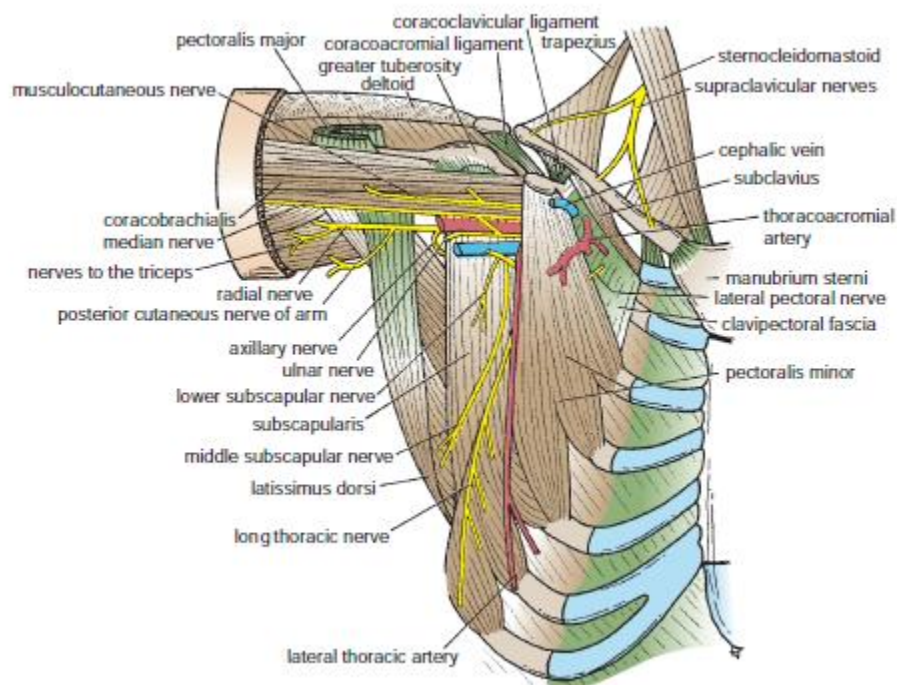


**FIGURE :** Inlet, walls, and outlet of the right axilla.





**FIGURE :** Pectoral region and axilla.



**FIGURE :** Pectoral region and axilla; the pectoralis major muscle has been removed to display the underlying structures.

**TABLE 9.1 Muscles Connecting the Upper Limb to the Thoracic Wall**

Muscle	Origin	Insertion	Nerve Supply	Nerve Roots*	Action
Pectoralis major	Clavicle, sternum, and upper six costal cartilages	Lateral lip of bicipital groove of humerus	Medial and lateral pectoral nerves from brachial plexus	C5, 6, 7, 8; T1	Adducts arm and rotates it medially; clavicular fibers also flex arm
Pectoralis minor	3rd, 4th, and 5th ribs	Coracoid process of scapula	Medial pectoral nerve from brachial plexus	C6, 7, 8	Depresses point of shoulder; if the scapula is fixed, it elevates the ribs of origin
Subclavius	1st costal cartilage	Clavicle	Nerve to subclavius from upper trunk of brachial plexus	C5, 6	Depresses the clavicle and steadies this bone during movements of the shoulder girdle
Serratus anterior	Upper eight ribs	Medial border and inferior angle of scapula	Long thoracic nerve	C5, 6, 7	Draws the forward anterior around the thoracic wall; rotates scapula

**TABLE 9.2 Muscles Connecting the Upper Limb to the Vertebral Column**

Muscle	Origin	Insertion	Nerve Supply	Nerve Roots*	Action
Trapezius	Occipital bone, ligamentum nuchae, spine of 7th cervical vertebra, spines of all thoracic vertebrae	Upper fibers into lateral third of clavicle; middle and lower fibers into acromion and spine of scapula	Spinal part of accessory nerve (motor) and C3 and 4 (sensory)	XI <b>cranial nerve</b> (spinal part)	Upper fibers elevate the scapula; middle fibers pull scapula medially; lower fibers pull medial border of scapula downward
Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower three or four ribs, and inferior angle of scapula	Floor of bicipital groove of humerus	Thoracodorsal nerve	C6, 7, 8,	Extends, adducts, and medially rotates the arm
Levator scapulae	Transverse processes of 1st four cervical vertebrae	Medial border of scapula	C3 and 4 and dorsal scapular nerve	C3, 4, 5	Raises medial border of scapula
Rhomboid minor	Ligamentum nuchae and spines of 7th cervical and 1st thoracic vertebrae	Medial border of scapula	Dorsal scapular nerve	C4, 5	Raises medial border of scapula upward and medially
Rhomboid major	Second to 5th thoracic spines	Medial border of scapula	Dorsal scapular nerve	C4, 5	Raises medial border of scapula upward and medially



**TABLE 9.3**     **Muscles Connecting the Scapula to the Humerus**

<b>Muscle</b>	<b>Origin</b>	<b>Insertion</b>	<b>Nerve Supply</b>	<b>Nerve Roots<sup>a</sup></b>	<b>Action</b>
Deltoid	Lateral third of clavicle, acromion, spine of scapula	Middle of lateral surface of shaft of humerus	Axillary nerve	C5, 6	Abducts arm; anterior fibers flex and medially rotate arm; posterior fibers extend and laterally rotate arm
Supraspinatus	Supraspinous fossa of scapula	Greater tuberosity of humerus; capsule of shoulder joint	Suprascapular nerve	C4, 5, 6	Abducts arm and stabilizes shoulder joint
Infraspinatus	Infraspinous fossa of scapula	Greater tuberosity of humerus; capsule of shoulder joint	Suprascapular nerve	(C4), 5, 6	Laterally rotates arm and stabilizes shoulder joint
Teres major	Lower third of lateral border of scapula	Medial lip of bicipital groove of humerus	Lower subscapular nerve	C6, 7	Medially rotates and adducts arm and stabilizes shoulder joint
Teres minor	Upper two thirds of lateral border of scapula	Greater tuberosity of humerus; capsule of shoulder joint	Axillary nerve	(C4), C5, 6	Laterally rotates arm and stabilizes shoulder joint
Subscapularis	Subscapular fossa	Lesser tuberosity of humerus	Upper and lower subscapular nerves	C5, 6, 7	Medially rotates arm and stabilizes shoulder joint

## **Axillary Artery**

The axillary artery begins at the lateral border of the 1st rib as a continuation of the subclavian and ends at the lower border of the teres major muscle, where it continues as the brachial artery. Throughout its course, the artery is closely related to the cords of the brachial plexus and their branches and is enclosed with them in a connective tissue sheath called the **axillary sheath**. If this sheath is traced upward into the root of the neck, it is seen to be continuous with the prevertebral fascia. The pectoralis minor muscle crosses in front of the axillary artery and divides it into three parts .

**First Part of the Axillary Artery** This extends from the lateral border of the 1st rib to the upper border of the pectoralis minor.

### **Relations**

- **Anteriorly:** The pectoralis major and the skin. The cephalic vein crosses the artery.
- **Posteriorly:** The long thoracic nerve (nerve to the serratus anterior).
- **Laterally:** The three cords of the brachial plexus.
- **Medially:** The axillary vein .

**Second Part of the Axillary Artery** This lies behind the pectoralis minor muscle

### **Relations**

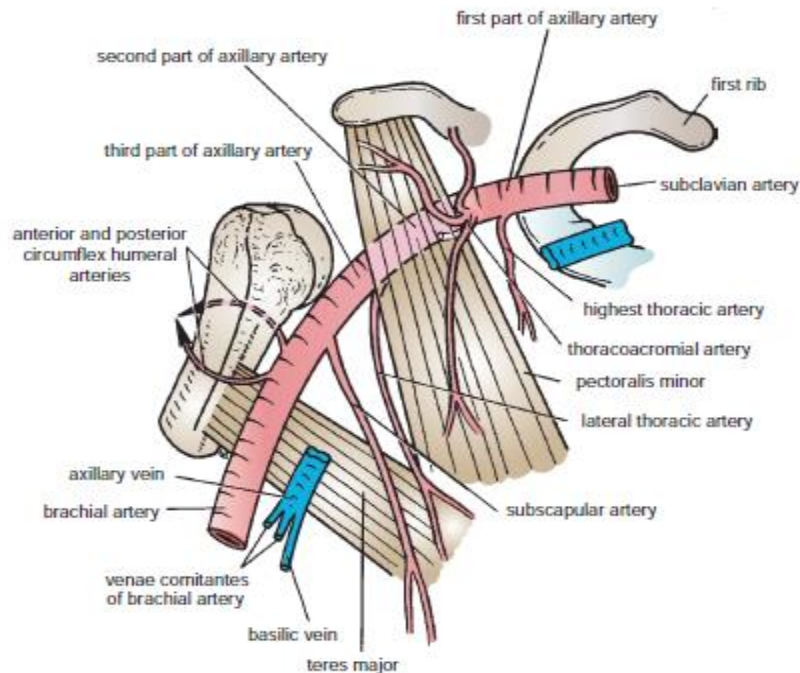
- **Anteriorly:** The pectoralis minor, the pectoralis major, and the skin.
- **Posteriorly:** The posterior cord of the brachial plexus, the subscapularis muscle, and the shoulder joint.
- **Laterally:** The lateral cord of the brachial plexus (Figs.
- **Medially:** The medial cord of the brachial plexus and the axillary vein.

**Third Part of the Axillary Artery** This extends from the lower border of the pectoralis minor to the lower border of the teres major.

### **Relations**

- **Anteriorly:** The pectoralis major for a short distance; lower down the artery, it is crossed by the medial root of the median nerve.
- **Posteriorly:** The subscapularis, the latissimus dorsi, and the teres major. The axillary and radial nerves also lie behind the artery.
- **Laterally:** The coracobrachialis, the biceps, and the humerus. The lateral root of the median and the musculocutaneous nerves also lie on the lateral side.

- Medially: The ulnar nerve, the axillary vein, and the medial cutaneous nerve of the arm.



**FIGURE 9.17** Parts of the axillary artery and its branches. Note the formation of the axillary vein at the lower border of the teres major muscle.

### **Branches of the Axillary Artery**

#### From the first part:

The **highest thoracic artery** is small and runs along the upper border of the pectoralis minor.

#### From the second part:

The **thoracoacromial artery** immediately divides into terminal branches.

The **lateral thoracic artery** runs along the lower border of the pectoralis minor.

#### From the third part:

The **subscapular artery** runs along the lower border of the subscapularis muscle.

The **anterior** and **posterior circumflex humeral arteries** wind around the front and the back of the surgical neck of the humerus, respectively.

### **Axillary Vein**

The axillary vein is formed at the lower border of the teres major muscle by the union of the venae comitantes of the brachial artery and the basilic vein.

It runs upward on the medial side of the axillary artery and ends at the lateral border of the 1st rib by becoming the subclavian vein.

The vein receives tributaries, which correspond to the branches of the axillary artery, and the cephalic vein.

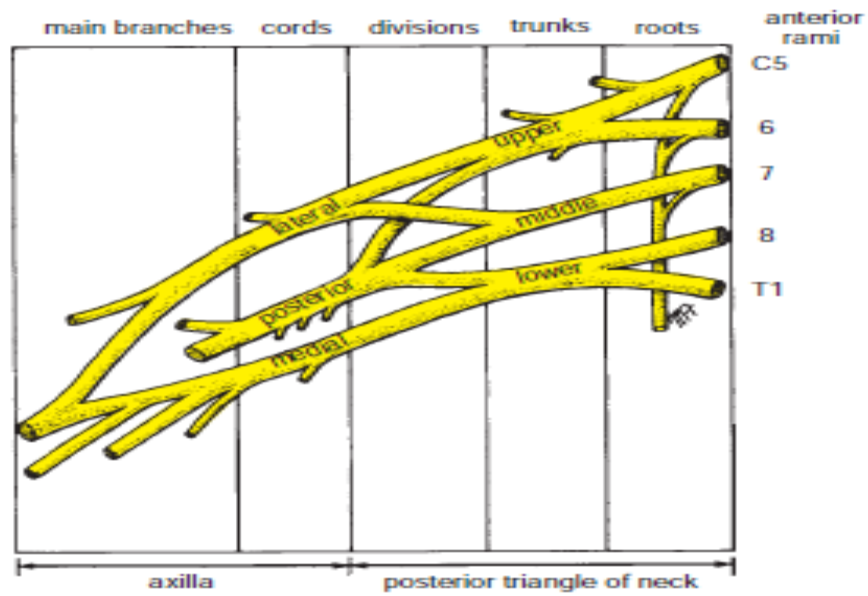
### **Brachial Plexus**

The nerves entering the upper limb provide the following important functions: sensory innervation to the skin and deep structures, such as the joints; motor innervation to the muscles; influence over the diameters of the blood vessels by the sympathetic vasomotor nerves; and sympathetic secretomotor supply to the sweat glands.

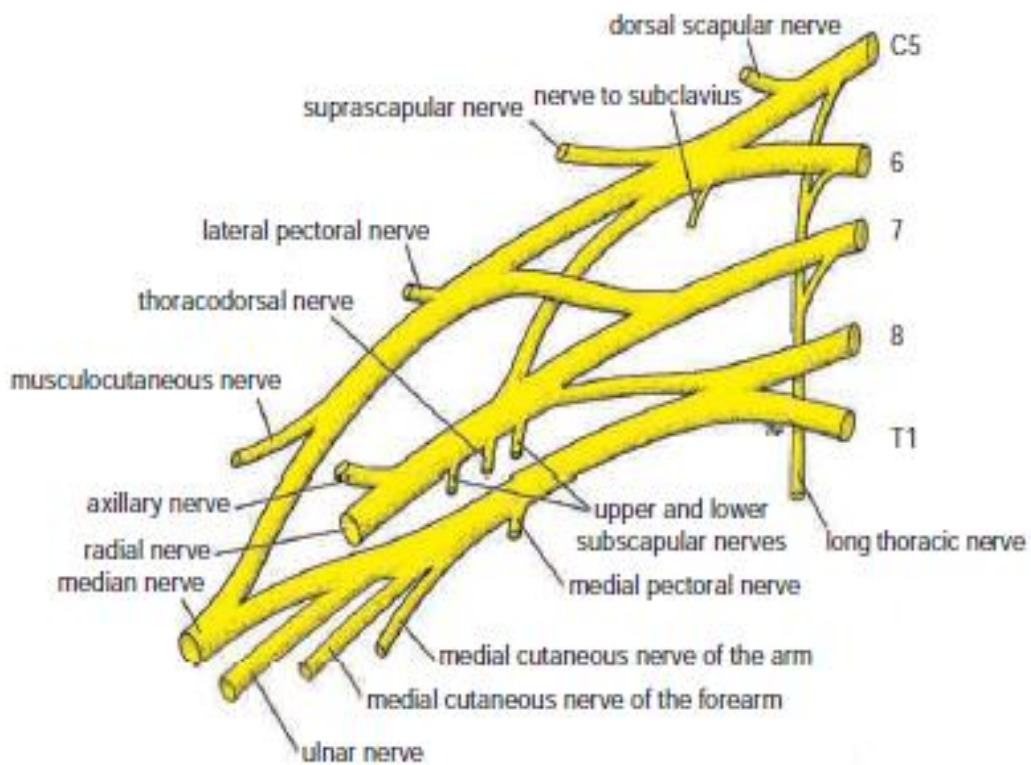
At the root of the neck, the nerves form a complicated plexus called the brachial plexus. This allows the nerve fibers derived from different segments of the spinal cord to be arranged and distributed efficiently in different nerve trunks to the various parts of the upper limb. The brachial plexus is formed in the posterior triangle of the neck by the union of the anterior rami of the 5th, 6th, 7th, and 8th cervical and the 1st thoracic spinal nerves. The plexus can be divided into roots, trunks, divisions, and cords. The roots of C5 and 6 unite to form the upper trunk, the root of C7 continues as the middle trunk, and the roots of C8 and T1 unite to form the lower trunk. Each trunk then divides into anterior and posterior divisions. The anterior divisions of the upper and middle trunks unite to form the lateral cord, the anterior division of the lower trunk continues as the medial cord, and the posterior divisions of all three trunks join to form the posterior cord.

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. Cords of the Brachial Plexus All three cords of the brachial plexus lie above and lateral to the first part of the axillary artery. The medial cord crosses behind the artery to reach the medial side of the second part of the artery. The posterior cord lies behind the second part of the artery, and the lateral cord lies on the lateral side of the second part of the artery. Thus, the cords of the plexus have the relationship to the second part of the axillary artery that is indicated by their names. Most branches of the cords that form the main nerve trunks of the upper limb continue this relationship to the artery in its third part.



**FIGURE :** The formation of the main parts of the brachial plexus. Note the locations of the different parts.



**FIGURE :** Roots, trunks, divisions, cords, and terminal branches of the brachial plexus.



TABLE 9.4

Summary of the Branches of the Brachial Plexus and their Distribution

Branches	Distribution
<b>Roots</b>	
Dorsal scapular nerve (C5)	Rhomboid minor, rhomboid major, levator scapulae muscles
Long thoracic nerve (C5, 6, 7)	Serratus anterior muscle
<b>Upper Trunk</b>	
Suprascapular nerve (C5, 6)	Supraspinatus and infraspinatus muscles
Nerve to subclavius (C5, 6)	Subclavius
<b>Lateral Cord</b>	
Lateral pectoral nerve (C5, 6, 7)	Pectoralis major muscle
Musculocutaneous nerve (C5, 6, 7)	Coracobrachialis, biceps brachii, brachialis muscles; supplies skin along lateral border of forearm when it becomes the lateral cutaneous nerve of forearm
Lateral root of median nerve (C5, 6, 7)	See medial root of median nerve
<b>Posterior Cord</b>	
Upper subscapular nerve (C5, 6)	Subscapularis muscle
Thoracodorsal nerve (C6, 7, 8)	Latissimus dorsi muscle
Lower subscapular nerve (C5, 6)	Subscapularis and teres major muscles
Axillary nerve (C5, 6)	Deltoid and teres minor muscles; upper lateral cutaneous nerve of arm supplies skin over lower half of deltoid muscle
Radial nerve (C5, 6, 7, 8; T1)	Triceps, anconeus, part of brachialis, extensor carpi radialis longus; via deep radial nerve branch supplies extensor muscles of forearm: supinator, extensor carpi radialis brevis, extensor carpi ulnaris, extensor digitorum, extensor digiti minimi, extensor indicis, abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis; skin, lower lateral cutaneous nerve of arm, posterior cutaneous nerve of arm, and posterior cutaneous nerve of forearm; skin on lateral side of dorsum of hand and dorsal surface of lateral three and a half fingers; articular branches to elbow, wrist, and hand

<b>Medial Cord</b>	
Medial pectoral nerve (C8; T1)	Pectoralis major and minor muscles
Medial cutaneous nerve of arm joined by intercostal brachial nerve from second intercostal nerve (C8; T1, 2)	Skin of medial side of arm
Medial cutaneous nerve of forearm (C8; T1)	Skin of medial side of forearm
Ulnar nerve (C8; T1)	Flexor carpi ulnaris and medial half of flexor digitorum profundus, flexor digiti minimi, opponens digiti minimi, abductor digiti minimi, adductor pollicis, third and fourth lumbricals, interossei, palmaris brevis, skin of medial half of dorsum of hand and palm, skin of palmar and dorsal surfaces of medial one and a half fingers
Medial root of median nerve (with lateral root) forms median nerve (C5, 6, 7, 8; T1)	Pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum superficialis, abductor pollicis brevis, flexor pollicis brevis, opponens pollicis, first two lumbricals (by way of anterior interosseous branch), flexor pollicis longus, flexor digitorum profundus (lateral half), pronator quadratus; palmar cutaneous branch to lateral half of palm and digital branches to palmar surface of lateral three and a half fingers; articular branches to elbow, wrist, and carpal joints

## **Lymph Nodes of the Axilla**

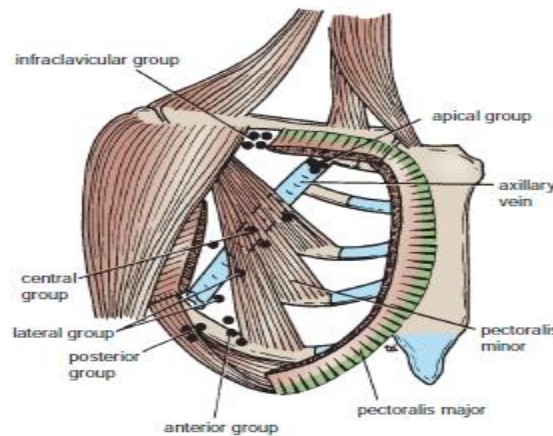
The axillary lymph nodes (20 to 30 in number) drain lymph vessels from the lateral quadrants of the breast, the superficial lymph vessels from the thoracoabdominal walls above the level of the umbilicus, and the vessels from the upper limb.

The lymph nodes are arranged in six groups.

- **Anterior (pectoral) group:** Lying along the lower border of the pectoralis minor behind the pectoralis major, these nodes receive lymph vessels from the lateral quadrants of the breast and superficial vessels from the anterolateral abdominal wall above the level of the umbilicus.
- **Posterior (subscapular) group:** Lying in front of the subscapularis muscle, these nodes receive superficial lymph vessels from the back, down as far as the level of the iliac crests.
- **Lateral group:** Lying along the medial side of the axillary vein, these nodes receive most of the lymph vessels of the upper limb (except those superficial vessels draining the lateral side—see infraclavicular nodes, below).
- **Central group:** Lying in the center of the axilla in the axillary fat, these nodes receive lymph from the above three groups.
- **Infraclavicular (deltopectoral) group:** These nodes are not strictly axillary nodes because they are located outside the axilla. They lie in the groove between the deltoid and pectoralis major muscles and receive superficial lymph vessels from the lateral side of the hand, forearm, and arm.

- **Apical group:** Lying at the apex of the axilla at the lateral border of the 1st rib, these nodes receive the efferent lymph vessels from all the other axillary nodes.

The apical nodes drain into the **subclavian lymph trunk**. On the left side, this trunk drains into the thoracic duct; on the right side, it drains into the right lymph trunk. Alternatively, the lymph trunks may drain directly into one of the large veins at the root of the neck.



**FIGURE :** Different groups of lymph nodes in the axilla.

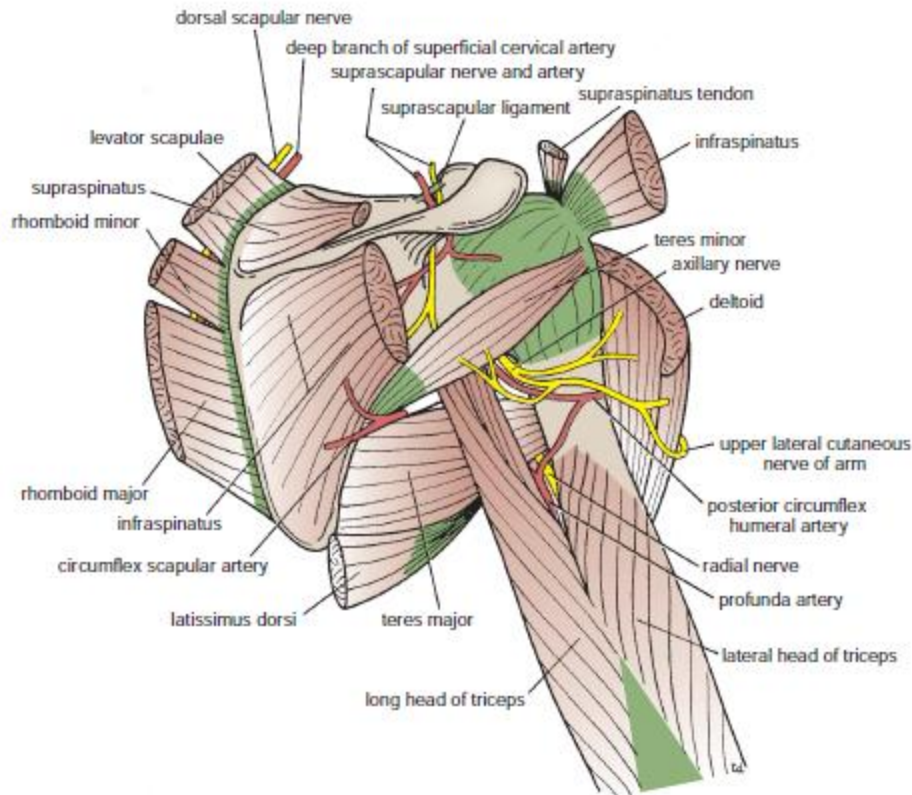
## **Rotator Cuff**

The rotator cuff is the name given to the tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles, which are fused to the underlying capsule of the shoulder joint. The cuff plays a very important role in stabilizing the shoulder joint.

The tone of these muscles assists in holding the head of the humerus in the glenoid cavity of the scapula during movements at the shoulder joint. The cuff lies on the anterior, superior, and posterior aspects of the joint. The cuff is deficient inferiorly, and this is a site of potential weakness.

## **Quadrangular Space**

The quadrangular space is an intermuscular space, located immediately below the shoulder joint. It is bounded above by the subscapularis and capsule of the shoulder joint and below by the teres major muscle. It is bounded medially by the long head of the triceps and laterally by the surgical neck of the humerus. The axillary nerve and the posterior circumflex humeral vessels pass backward through this space.



**FIGURE:** Muscles, nerves, and blood vessels of the scapular region. Note the close relation of the axillary nerve to the shoulder joint.

### **Sternoclavicular Joint**

- **Articulation:** This occurs between the sternal end of the clavicle, the manubrium sterni, and the 1st costal cartilage
- **Type:** Synovial double-plane joint
- **Capsule:** This surrounds the joint and is attached to the margins of the articular surfaces.
- **Ligaments:** The capsule is reinforced in front of and behind the joint by the strong **sternoclavicular ligaments**.
- **Articular disc:** This flat fibrocartilaginous disc lies within the joint and divides the joint's interior into two compartments. Its circumference is attached to the interior of the capsule, but it is also strongly attached to the superior margin of the articular surface of the clavicle above and to the first costal cartilage below.
- **Accessory ligament:** The **costoclavicular ligament** is a strong ligament that runs from the junction of the 1<sup>st</sup> rib with the 1st costal cartilage to the inferior surface of the sternal end of the clavicle.

- **Synovial membrane:** This lines the capsule and is attached to the margins of the cartilage covering the articular surfaces.
- **Nerve supply:** The supraclavicular nerve and the nerve to the subclavius muscle.

## **Movements**

Forward and backward movement of the clavicle takes place in the medial compartment. Elevation and depression of the clavicle take place in the lateral compartment.

## **Muscles Producing Movement**

- ✓ The forward movement of the clavicle is produced by the serratus anterior muscle.
- ✓ The backward movement is produced by the trapezius and rhomboid muscles.
- ✓ Elevation of the clavicle is produced by the trapezius, sternocleidomastoid, levator scapulae, and rhomboid muscles.
- ✓ Depression of the clavicle is produced by the pectoralis minor and the subclavius muscles.
- ✓

## **Important Relations**

- **Anteriorly:** The skin and some fibers of the sternocleidomastoid and pectoralis major muscles
- **Posteriorly:** The sternohyoid muscle; on the right, the brachiocephalic artery; on the left, the left brachiocephalic vein and the left common carotid artery

## **Acromioclavicular Joint**

- **Articulation:** This occurs between the acromion of the scapula and the lateral end of the clavicle.
- **Type:** Synovial plane joint
- **Capsule:** This surrounds the joint and is attached to the margins of the articular surfaces.
- **Ligaments:** **Superior** and **inferior acromioclavicular ligaments** reinforce the capsule; from the capsule, a wedge-shaped **fibrocartilaginous disc** projects into the joint cavity from above.
- **Accessory ligament:** The very strong **coracoclavicular ligament** extends from the coracoid process to the undersurface of the clavicle. It is largely responsible for suspending the weight of the scapula and the upper limb from the clavicle.



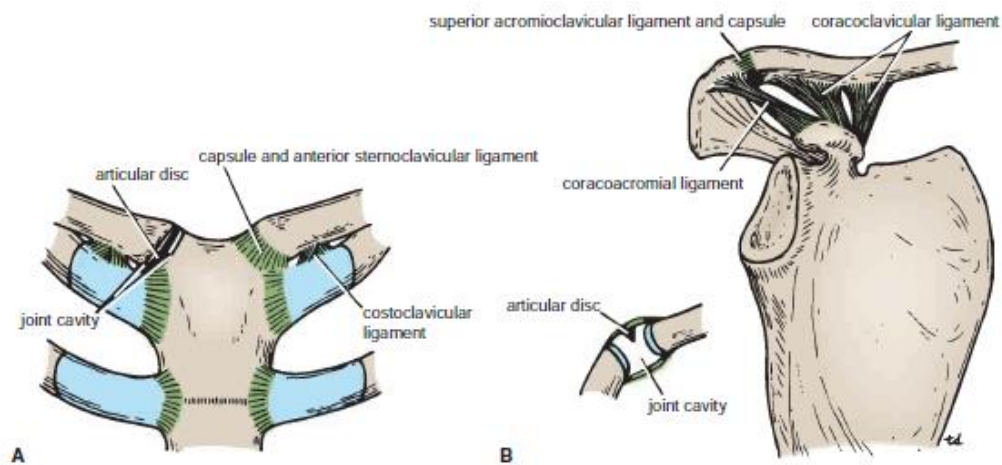
- **Synovial membrane:** This lines the capsule and is attached to the margins of the cartilage covering the articular surfaces.
- **Nerve supply:** The suprascapular nerve

### Movements

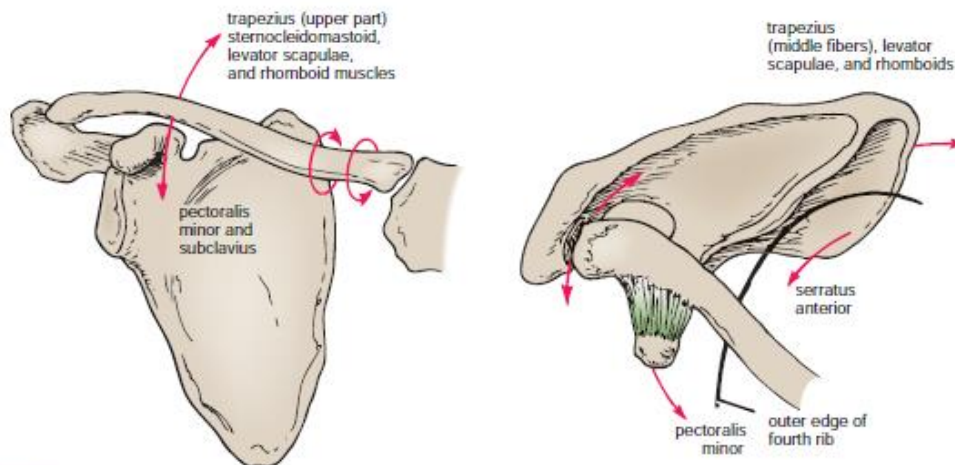
A gliding movement takes place when the scapula rotates or when the clavicle is elevated or depressed.

### Important Relations

- ✓ **Anteriorly:** The deltoid muscle
- ✓ **Posteriorly:** The trapezius muscle
- ✓ **Superiorly:** The skin



**FIGURE 9.32** A. Sternoclavicular joint. B. Acromioclavicular joint.



**FIGURE 9.33** The wide range of movements possible at the sternoclavicular and the acromioclavicular joints gives great mobility to the clavicle and the upper limb.

## **Shoulder Joint**

- **Articulation:** This occurs between the rounded head of the humerus and the shallow, pear-shaped glenoid cavity of the scapula. The articular surfaces are covered by hyaline articular cartilage, and the glenoid cavity is deepened by the presence of a fibrocartilaginous rim called the **glenoid labrum**.
- **Type:** Synovial ball-and-socket joint
- **Capsule:** This surrounds the joint and is attached medially to the margin of the glenoid cavity outside the labrum; laterally, it is attached to the anatomic neck of the humerus (Fig. 9.35). The capsule is thin and lax, allowing a wide range of movement. It is strengthened by fibrous slips from the tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles (the rotator cuff muscles).
- **Ligaments:** The **glenohumeral ligaments** are three weak bands of fibrous tissue that strengthen the front of the capsule. The **transverse humeral ligament** strengthens the capsule and bridges the gap between the two tuberosities. The **coracohumeral ligament** strengthens the capsule above and stretches from the root of the coracoid process to the greater tuberosity of the humerus.
- **Accessory ligaments:** The **coracoacromial ligament** extends between the coracoid process and the acromion. Its function is to protect the superior aspect of the joint.
- **Synovial membrane:** This lines the capsule and is attached to the margins of the cartilage covering the articular surfaces. It forms a tubular sheath around the tendon of the long head of the biceps brachii. It extends through the anterior wall of the capsule to form the **subscapularis bursa** beneath the subscapularis muscle.
- **Nerve supply:** The axillary and suprascapular nerves

## **Movements**

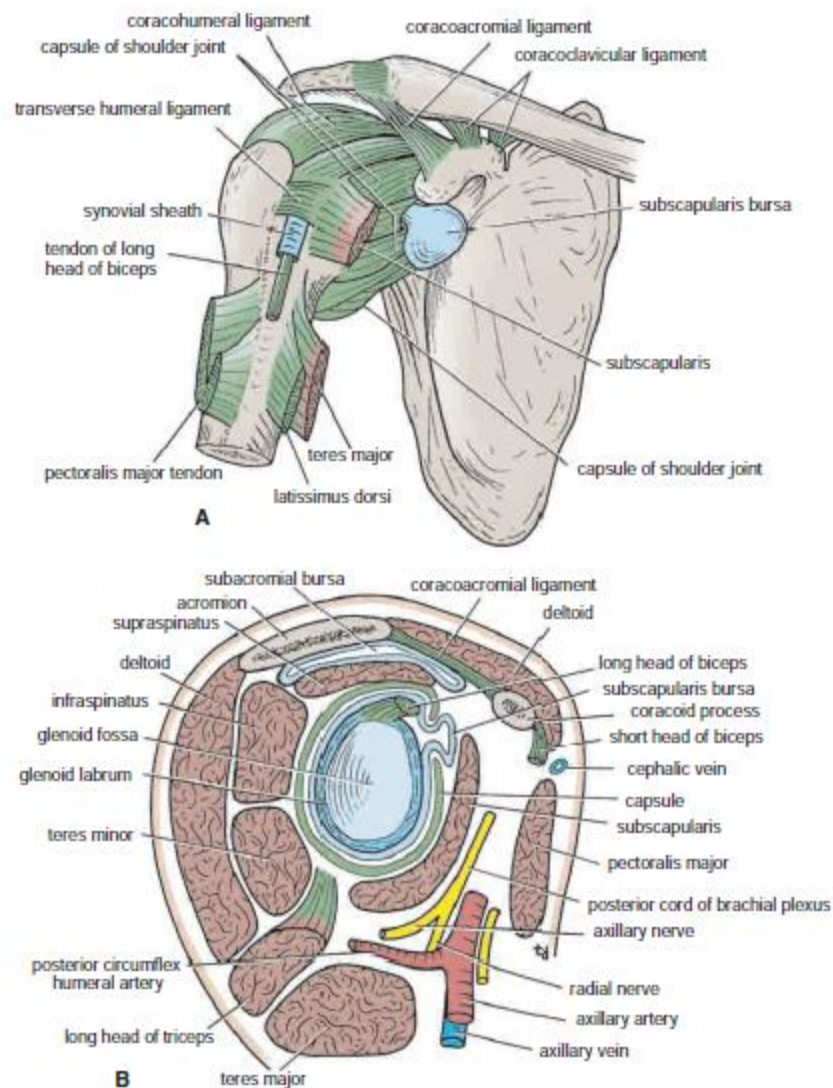
The shoulder joint has a wide range of movement, and the stability of the joint has been sacrificed to permit this. (Compare with the hip joint, which is stable but limited in its movements.)

The following movements are possible:

- **Flexion:** Normal flexion is about 90° and is performed by the anterior fibers of the deltoid, pectoralis major, biceps, and coracobrachialis muscles.
- **Extension:** Normal extension is about 45° and is performed by the posterior fibers of the deltoid, latissimus dorsi, and teres major muscles.
- **Abduction:** Abduction of the upper limb occurs both at the shoulder joint and between the scapula and the thoracic wall. The middle fibers of the

deltoid, assisted by the supraspinatus, are involved. The supraspinatus muscle initiates the movement of abduction and holds the head of the humerus against the glenoid fossa of the scapula; this latter function allows the deltoid muscle to contract and abduct the humerus at the shoulder joint.

- **Adduction:** Normally, the upper limb can be swung  $45^{\circ}$  across the front of the chest. This is performed by the pectoralis major, latissimus dorsi, teres major, and teres minor muscles.
- **Lateral rotation:** Normal lateral rotation is  $40^{\circ}$  to  $45^{\circ}$ . This is performed by the infraspinatus, the teres minor, and the posterior fibers of the deltoid muscle.
- **Medial rotation:** Normal medial rotation is about  $55^{\circ}$ . This is performed by the subscapularis, the latissimus dorsi, the teres major, and the anterior fibers of the deltoid muscle.
- **Circumduction:** This is a combination of the above movements.



**FIGURE 9.34** Shoulder joint and its relations. **A.** Anterior view. **B.** Sagittal section.