Upper Limb

INTRODUCTION

Human beings belong to the Order Primates. This group of mammals are more renowned for their adaptability than for their adaptation, thus they have avoided the pitfalls of specialisation and consequently have become the most flourishing group of mammals during the past 50 to 60 million years. Most primates are arboreal. This arboreal habitat has not only given them security from enemies, but also has improved their sense of vision. With this improvement in visual perception there has been a corresponding reduction of their olfactory sense organs, the latter having become unimportant in an arboreal environment. This reduction of the olfactory apparatus has been accompanied by a recession of the snout which is the region of exquisite tactile sensibility in macrosmatic animals. In the human species, this tactile function is taken over chiefly by the upper limbs, which have become emancipated from the burden of weight-bearing. Such tactile sensibility has become specially marked towards the distal parts of the upper limb, i.e. digits.

Moreover, humans have also inherited the prehensile or grasping function of the upper limbs from their arboreal ancestry. Superimposed on to the more primitive prehensile function of the hand is the evolution of finer precision movements. Thus the hand has developed into a prehensile organ possessing strength, stability, mobility, a high degree of neuromuscular coordination and sensory discrimination. This, together with the specialised development of the human brain, i.e. the combination of the human hand

and mind, has culminated in the manufacture and use of tools, thus giving birth to the rich human cultural activities of arts and crafts. Consequently the human hand is both a sensory and a motor apparatus. One also has to be aware that although over the past 50 million years there has been little change in the *structure* of the skeleton and muscles of the hand, the changes in *function* have been profound. For example, the opposability of the thumb to the index finger is a unique human trait and it is important to realise that functionally the thumb represents one half of the hand. And in connection with the functional aspect, the clinical importance of the hand is obvious since 45 per cent of all industrial injuries are associated with the hand.

In the study of the upper limb as well as other parts of the body, you must bear in mind the functional correlates of the morphological structures that you encounter during the dissection sessions.

Overview of Schedule 1

Before you begin dissection note:

PECTORAL REGION AND AXILLA

Relevant skeletal features:

thoracic cage — sternum; costal cartilages; ribs and thoracic vertebrae;
sternum — manubrium; body; xiphoid process; jugular notch; sternal angle;
first rib — surfaces; borders; ends;
clavicle — medial end; shaft; lateral end;
scapula — surfaces; borders; processes (spine, acromion, coracoid);
humerus — head; greater and lesser tubercles; crests of the greater and lesser tubercles; intertubercular groove; surgical neck.

Subcutaneous structures:

mammary gland; supraclavicular nerves; anterior and lateral cutaneous branches of intercostal nerves and accompanying arteries; cephalic vein.

Deep fascia:

pectoral; clavipectoral; axillary.

Muscles:

pectoralis major; obliquus externus abdominis; serratus anterior; pectoralis minor; subclavius; subscapularis; teres major; latissimus dorsi; coracobrachialis; short head of biceps; long head of triceps; deltoid.

Boundaries of Axilla

Nerves:

roots, trunks, divisions and cords of *brachial plexus*.

Arteries:

axillary artery and its branches.

Veins:

axillary vein and its tributaries.

Lymph nodes:

axillary groups.

Surface anatomy:

axillary artery.

Clinical anatomy:

injuries to brachial plexus; lymph drainage of breast.

Dissection Schedule 1

PECTORAL REGION AND AXILLA

1. *With the body on its back make the following incisions:*
   (a) *a median incision extending from the* **jugular notch** *to the* **xiphoid process**;
   (b) *from the jugular notch along the* **clavicle** *to the* **acromion process of the scapula**, *continue the cut down the lateral side of the arm to its middle;*
   (c) *a transverse incision from the lower end of incision* (b) *to the medial side of the arm;*
   (d) *from the xiphoid process horizontally to the* **posterior axillary line**; and
   (e) *encircle the* **nipple**.
   Reflect the skin flaps.

2. *As you dissect below the clavicle you may come across the following cutaneous nerves but do not spend time searching for them*:
   (a) the cutaneous **medial, intermediate** and **lateral supraclavicular nerves** which descend over the clavicle. These nerves are branches of the cervical plexus and supply the skin of the upper pectoral and shoulder regions;
   (b) the **anterior cutaneous branches** of the intercostal nerves lateral to the sternum which are accompanied by **perforating branches** of the **internal thoracic artery**. These nerves and vessels emerge about 3 cm from the midline; and
   (c) the **lateral cutaneous branches** of the **intercostal (thoracic) nerves** which emerge along the **midaxillary line** and divide into anterior and posterior branches.

3. *Examine the extent of the* **female breast** *lying in* the superficial fascia and note that there is an extension of the breast tissue into the axilla **(axillary tail)**. *Make a transverse cut across the breast passing through the nipple. Try to identify some of the lobes and ducts of the gland.* Note the **suspensory ligaments** which are *fibrous strands* passing from the nipple and skin of the breast to the deeper layer of superficial fascia.

4. *Remove the breast and the remains of the superficial fascia* and note the underlying **pectoralis major muscle** which is covered by deep fascia known as the **pectoral fascia**. *Remove this deep fascia.* Below and lateral to the pectoralis major, *you will see* the interdigitating slips of origin of the **obliquus externus abdominis** and **serratus anterior muscles**.

5. *Identify the clavicular part of the pectoralis major* and note that the **cephalic vein** lies in a groove between it and the **deltoid muscle (deltopectoral groove)**.

6. Note that the pectoralis major arises from: (a) the medial half of the anterior surface of the clavicle; (b) the sternum; and (c) the upper six costal cartilages. *Cut the muscle close to its origins and reflect it laterally*. The **lateral** and **medial pectoral nerves** supply the pectoralis major and the underlying **pectoralis minor muscle**. Note that the pectoralis major muscle is inserted into the **crest of the greater tubercle of the humerus**.

7. *Define the underlying* **clavipectoral fascia** which lies between the clavicle and the upper border of the pectoralis minor. This fascia splits above to enclose the **subclavius muscle** lying below the clavicle and the pectoralis minor below. *Clean the subclavius* which passes from the first rib to the inferior surface of the clavicle.

8. *As you clean away the fascia,* note that the cephalic vein pierces the clavipectoral fascia in the **infraclavicular fossa** and drains into the **axillary vein**.

9. *Next clean the pectoralis minor* and note its origin from ribs 3, 4, 5 and its insertion into the **coracoid process of the scapula**.

   Note that the pectoralis major, clavipectoral fascia, subclavius and the pectoralis minor form the **anterior wall of the axilla**.

10. *Clean the* **axillary fascia** which is a continuation of the pectoral fascia. This fascia forms the **base of the axilla**. Embedded within fascia, *you may find the* **axillary lymph nodes** which are arranged as follows:
    (a) a **pectoral** or **anterior group** along the lower border of pectoralis minor;

(b) a **brachial** or **lateral group** along the lower part of the axillary vein;
(c) a **central group** in relation to the central part of the axillary vein;
(d) an **apical group** along the axillary vein at the apex of the axilla; and
(e) a **subscapular** or **posterior group** along the **subscapular** vessels.

11. *Reflect pectoralis minor from its origin. Identify the* **axillary artery** and note that the pectoralis minor divides the course of this vessel into three parts. The *first part* is proximal to the muscle, the *second part* lies behind the muscle while the *third part* is distal to the muscle. *At the same time clean the axillary vein*.

12. *Now examine the part of the* **brachial plexus** *lying in the axilla*. Note that the brachial plexus lies partly in the neck, partly behind the clavicle and partly in the axilla. The plexus is made up of **roots, trunks, divisions, cords** and **branches**.

    The *roots* are the anterior primary rami of C5, 6, 7, 8 and T1 and communications from C4 and T2. The roots lie in the neck.

    The *trunks* are **upper, middle** and **lower**, and they too lie in the neck.

    The *divisions* lie behind the clavicle.

    The *cords* are **lateral, posterior** and **medial**, and they lie in the axilla. These cords are associated with the first and second parts of the axillary artery, and give rise to *branches* that are associated with the third part of the axillary artery.

13. *Now proceed to clean the branches of the cords in relation to the third part of the axillary artery:*
    (a) the **medial cutaneous nerve of arm** lying medial to the axillary vein, this supplies the medial side of the arm (*do not waste time searching for it*);
    (b) the **medial cutaneous nerve of forearm** running superficially between the vein and the artery, this supplies the medial side of the forearm;
    (c) the **ulnar nerve**, lying between the vein and the artery but in a deeper plane to the medial cutaneous nerve of forearm;
    (d) the **median nerve** lying lateral to the artery. Observe that this nerve has two roots, the **medial root** which crosses in front of the artery to join the **lateral root** lying lateral to the artery;

(e) the **musculocutaneous nerve** situated lateral to the median nerve and supplying the coracobrachialis, biceps and brachialis muscles. *Trace the medial cutaneous nerve of forearm and ulnar nerve proximally to their origins from the* **medial cord** of the brachial plexus *and the musculocutaneous nerve to its origin from the* **lateral cord**. Note that the medial root of the median nerve arises from the medial cord and the lateral root of the nerve from the lateral cord of the plexus. Observe that the *medial cord is medial* to the *second part* of the axillary artery while the *lateral cord* is *lateral* to the artery; and

(f) the **axillary** and **radial nerves** situated behind the artery. *Trace them to their origins from the* **posterior cord** of the brachial plexus which lies *behind* the *second part* of the axillary artery.

The three cords of the brachial plexus are in fact named according to their relationship to the *second part* of the axillary artery.

14. *Identify the* **subscapularis, teres major** and **latissimus dorsi muscles** which form the *posterior wall of the axilla*. *Trace the* **thoracodorsal nerve** which is accompanied by the **subscapular vessels**. Note the entry of the nerve and vessels into the latissimus dorsi muscle at its **neurovascular hilus**. The subscapularis and teres major muscles are supplied by the **subscapular nerves**.

15. The axillary artery has numerous branches. One of the major branches is the **subscapular artery**. *Clean the artery* and note that it lies along the posterior wall of the axilla. Another set of branches are the **circumflex humeral arteries** that supply the shoulder joint.

16. *Trace and observe that the axillary nerve passes through the* **quadrilateral space** bounded by the subscapularis above, teres major below, **long head of triceps** medially and the upper end of the humerus laterally.

17. *Clean the latissimus dorsi and teres major muscles close to their insertions into the floor of the* **intertubercular groove** *and* **crest of the lesser tubercle of the humerus** *respectively*. Note that the *lateral wall of the axilla* is narrow due to the convergence of the anterior and posterior walls towards the intertubercular groove. Between the

converging walls lie the **short head of biceps** and **coracobrachialis muscles**.

18. Note that the **serratus anterior muscle** takes origin from the upper eight ribs and is inserted into the medial border of the **scapula**. It forms the *medial wall of the axilla*. *Secure the* **long thoracic nerve** on the lateral side of the thorax. It arises from the nerve roots of C5, 6, 7 and supplies the muscle on its external surface.

Summary

The axilla may be regarded as a three sided pyramid whose truncated apex is situated between the clavicle, upper border of the scapula and outer border of the first rib. Nerves supplying the upper limb descend from the lower part of the neck through the apex of the axilla. These nerves form the brachial plexus. The plexus supplies the entire upper limb musculature with the exception of the trapezius and the levator scapulae.

The brachial plexus is formed by the anterior rami of C5, 6, 7, 8 and T1 nerves. It has the following stages:

roots:	C5, 6, 7, 8, T1
trunks:	**upper trunk** formed by the union of C5, 6
	middle trunk formed by C7
	lower trunk formed by the union of C8, T1
divisions:	each trunk divides into an **anterior** and a **posterior division**
cords:	**lateral cord** formed by the anterior divisions of the upper and middle trunks (C5, 6, 7)
	medial cord formed by the anterior division of the lower trunk (C8, T1)
	posterior cord formed by the posterior divisions of the upper, middle and lower trunks (C5, 6, 7, 8 [T1]).

The *roots* and *trunks* of the plexus are found *in the neck*, the *divisions* of the trunks *behind the clavicle*, and the *cords* and *branches* in the *axilla*.

The nerves forming the plexus lie behind the plane of the vessels in the neck and subsequently undergo re-arrangement in the axilla so that the medial, lateral and posterior cords assume their respective positions around

the *second part* of the **axillary artery**. Distal to this, the lateral cord and its branches lie above and lateral to the artery, the medial cord and its branches are below and medial to the artery, and the posterior cord and its branches lie posterior to the artery. Moreover, whenever nerves arising from the medial or lateral cords cross the artery, they usually do so in front of the artery, while those arising from the posterior cord cross behind the vessel.

It must be borne in mind that the anterior divisions of the brachial plexus supply the muscles forming the anterior wall of the axilla and the flexor muscles of the free upper limb, while the posterior divisions supply the muscles forming the posterior wall of the axilla and the extensor muscles of the free upper limb.

Lymphatic drainage of the breast

This is of importance in understanding the spread of breast cancer. The lymph vessels of the breast generally follow the course of blood vessels. They follow:

(a) along the lower border of pectoralis minor and drain mainly into the **pectoral group of axillary lymph nodes**;

(b) along the internal thoracic artery to the **internal thoracic lymph nodes**; and

(c) the posterior intercostal arteries to the **posterior intercostal nodes**.

Rarely, lymphatics from the breast may pass into the abdomen between the xiphoid process and the costal margin to end in the **diaphragmatic nodes**. They may even communicate with the lymphatics of the opposite breast.

Objectives for Dissection Schedule 1

1. PECTORAL REGION AND AXILLA

General objective 1

Comprehend the arrangement of the muscles in relation to the axilla.

Specific objectives:

1. Explain the pectoral region as a link between the trunk and mobile upper limb.
2. Demonstrate the actions of pectoralis major and minor.
3. Define the muscles contributing to the formation and contour of the anterior and posterior axillary folds.
4. Define the medial and lateral walls of the axilla.

General objective 2

Comprehend the arrangements of the nerves and blood vessels of the axilla.

Specific objectives:

1. Explain how the apex of the axilla forms the highway for nerves and blood vessels between the neck and upper limb.
2. Surface mark the axillary artery and define its extent.
3. Identify the roots, trunks, divisions and cords of the brachial plexus in prosected specimens.
4. Illustrate the functional aspects of the divisions of the plexus.
5. Explain this functional subdivision by taking individual nerves in turn.
6. Surface mark the pectoralis minor muscle and discuss why it is the key structure of the region.

2. THE MAMMARY GLAND

General objective:

Comprehend the general anatomy of the breast and the clinical importance of this knowledge.

Specific objectives:

1. Define the muscles forming the "bed" of the adult female breast.
2. Define the base of the gland and the axillary tail.
3. Outline the blood supply of the organ.
4. Outline routes of lymph drainage of the breast.
5. Discuss the clinical importance of the knowledge of the blood supply and lymphatic drainage of the breast.

Overview of Schedule 2

Before you begin dissection note:

FRONT OF ARM AND CUBITAL REGION

Relevant skeletal features:

humerus — deltoid tuberosity; supracondylar ridges; epicondyles;
radius — head; radial tuberosity;
ulna — coronoid process.

Subcutaneous structures:

medial cutaneous nerves of arm and forearm; upper and lower lateral cutaneous nerves of arm; lateral and posterior cutaneous nerves of forearm; cephalic, basilic and median cubital veins; cubital lymph nodes.

Deep fascia:

medial and lateral intermuscular septa; flexor and extensor compartments.

Muscles:

biceps brachii; brachialis; coracobrachialis; pronator teres; brachioradialis.

Boundaries of cubital fossa

Nerves:

musculocutaneous; ulnar; median; radial.

Arteries:

brachial artery and its branches; radial and ulnar arteries.

Veins:

venae comitantes of brachial artery.

Surface anatomy:

brachial artery.

Clinical anatomy:

suitability of antecubital veins for intravenous injections and taking blood for analysis and for transfusion.

Dissection Schedule 2

FRONT OF ARM AND CUBITAL REGION

1. *Make the following incisions:*
   (a) *from the lateral end of the transverse incision* (c) *of dissection Schedule 1, make a vertical incision along the lateral side of the upper limb to about the middle of the forearm.*
   (b) *carry this incision horizontally across the front of the forearm to its medial border.*

   Reflect the skin flap.

2. *Clean the* **cephalic** *and* **basilic veins** lying in the superficial fascia lateral and medial to the biceps brachii muscle respectively. The termination of the cephalic vein into the axillary vein has already been identified. Note that the basilic vein pierces the deep fascia about the middle of the arm and becomes the **axillary vein** at the lower border of the teres major. Observe the connections between the cephalic and basilic veins in the cubital fossa.

3. *Find the* **lateral cutaneous nerve of forearm** on the lateral side of the biceps in the cubital region. This is a continuation of the musculocutaneous nerve and supplies the skin on the lateral side of the forearm.

4. *Next find the* **medial cutaneous nerve of the forearm** *in the superficial fascia on the medial side*. It supplies the skin on the medial side of the forearm.

5. *Incise the deep fascia along the length of the arm in the midline. Make transverse cuts at the upper and lower ends and reflect the flaps. As you do so, observe the* **medial** *and* **lateral intermuscular septa** which are attached to the **medial** and **lateral supracondylar ridges** of the humerus, respectively. These septa divide the arm into an anterior *flexor* and a posterior *extensor* compartment.

6. *Clean the* **biceps brachii** *and* **coracobrachialis muscles**. Note that the tendon of the **long head of biceps** arises from the **supraglenoid tubercle** of the scapula. *Expose the part of the tendon which lies in the intertubercular groove by cutting through the fascial expansion from the pectoralis major. Observe the origin of the* **short head of biceps**

and coracobrachialis from the coracoid process of the scapula. Follow the coracobrachialis to its insertion into the middle of the medial side of the shaft of the humerus. Note that the musculocutaneous nerve enters the coracobrachialis in its upper part.

7. *Trace the median and ulnar nerves from the axilla into the arm. Observe* that the median nerve accompanies the **brachial artery**. *Secure the ulnar nerve* which accompanies the brachial artery in its upper part and then pierces the medial intermuscular septum at the mid-humeral level to enter the posterior compartment of the arm.
8. *Clean the brachial artery* and note that it has numerous branches.
9. *Trace the tendon of insertion of the biceps into the* **radial tuberosity** *and into the deep fascia of the forearm via the* **bicipital aponeurosis**.
10. *Divide the bicipital aponeurosis* and note the division of the brachial artery into **radial** and **ulnar arteries**.
11. *Trace the median nerve to its entry into the forearm* between the two heads of the **pronator teres muscle**. *Preserve the branches arising from the nerve*.
12. *Cut transversely across the middle of the biceps muscle and draw the two halves apart*. The musculocutaneous nerve will now be seen lying on the **brachialis muscle** which it supplies. Note the origin of the brachialis from the lower half of the anterior surface of the shaft of the humerus and its insertion into the **coronoid process of the ulna**.
13. In the distal fourth of the arm, *identify the radial nerve lying between the brachialis and* **brachioradialis muscles**. The nerve sends branches to these muscles.
14. Note the triangular **cubital fossa**. Its base is an imaginary line between the **medial** and **lateral epicondyles of the humerus**. The brachioradialis forms the lateral boundary and pronator teres forms the medial boundary of the fossa. The floor is formed by the brachialis above, which separates it from the **elbow joint**, and below by the **supinator muscle**. *Review the contents of the fossa*, from lateral to medial they are the tendon of biceps; the brachial artery with its terminal branches: radial and ulnar arteries; and the median nerve.

Summary

It will be observed that the anterior compartment of the arm contains the flexor muscles, i.e. coracobrachialis, biceps and brachialis which are innervated by the musculocutaneous nerve. The biceps muscle passes over both shoulder and elbow joints, and consequently has actions on both these joints, whereas the brachialis crossing only the elbow has its action solely on the elbow joint.

The **brachial artery** which commences at the lower border of the teres major lies in the groove between the flexor and extensor muscles down to the middle of the arm. The artery lies medial to the humerus in the upper part of the arm and in front of it and the brachialis lower down. The division of the brachial artery into **radial** and **ulnar arteries** usually occurs in the cubital fossa opposite the neck of the radius.

Objectives for Dissection Schedule 2

FRONT OF THE ARM AND CUBITAL FOSSA

General objective

Comprehend the principles of the arrangement of the muscles, nerves and blood vessels of the region.

Specific objectives:

1. Describe the formation of flexor and extensor compartments of the arm.
2. Illustrate the actions of individual muscles of the flexor compartment.
3. Define the position of the neurovascular bundle (median nerve and brachial artery) in the upper and lower parts of the arm and their relationship to the humerus.
4. Discuss the effects of lesion of the nerves supplying the flexor group in terms of segmental innervation of the elbow joint.
5. Surface mark the brachial artery and illustrate the points of arterial compression, the site for recording blood pressure and the vulnerability of the brachial artery in fractures of the lower end of the humerus (supracondylar fractures).
6. Understand the vulnerability of: (a) the median nerve in supracondylar fractures, and (b) the ulnar nerve in fracture of the medial epicondyle.
7. Review the boundaries and contents of the cubital fossa.

Overview of Schedule 3

Before you begin dissection note:

SUPERFICIAL DISSECTION OF BACK OF TRUNK, SCAPULAR REGION AND BACK OF ARM

Relevant skeletal features:

skull	—	mastoid process; superior nuchal line; external occipital protuberance;
vertebral column	—	spines of vertebrae; vertebra prominens C7 (or T1); sacrum; coccyx;
hip bone	—	iliac crest; posterior superior iliac spine at the level of S2 spine;
scapula	—	medial, superior and lateral (axillary) borders; scapular notch; spine of scapula; supra- and infraspinous fossae; spinoglenoid notch; glenoid cavity; infraglenoid tubercle; superior angle at the level of T2 spine; inferior angle at the level of T7 spine;
humerus	—	greater and lesser tubercles; deltoid tuberosity; radial groove;
ulna	—	olecranon process.

Subcutaneous structures:

cutaneous branches of dorsal rami; posterior cutaneous nerve of arm.

Deep fascia:

thoracolumbar fascia.

Ligaments:

ligamentum nuchae; supraspinous ligaments; coracoacromial ligament; superior transverse scapular ligament.

Muscles:

trapezius; latissimus dorsi; levator scapulae; rhomboid minor and major; deltoid; supraspinatus; infraspinatus; teres major and minor; inferior

belly of omohyoid; subscapularis; serratus anterior; triceps brachii; anconeus.

Boundaries of quadrangular space.

Nerves:

accessory; suprascapular; axillary; other nerves supplying muscles.

Arteries:

transverse cervical; suprascapular; subscapular; anatosmoses around scapula; circumflex humeral.

Surface anatomy:

axillary nerve; radial nerve.

Clinical anatomy:

fracture of the neck of the humerus; fracture of the middle of the shaft of the humerus.

Dissection Schedule 3

SUPERFICIAL DISSECTION OF BACK OF TRUNK, SCAPULAR REGION AND BACK OF ARM

1. *With the body in the prone position make the following incisions:*
   (a) *a midline incision from about the spine of T1 down to the tip of the* **coccyx**;
   (b) *from the tip of the coccyx curving upwards and laterally along the* **iliac crest** *to the mid-axillary line* (*if not already done*);
   (c) *from the spine of L1 vertebra laterally to the* **midaxillary line**;
   (d) *from the spine of T1 laterally to about 2 cm above the lateral end of the clavicle; and*
   (e) *cut transversely across the middle of the back of the forearm to its medial border.*

   Reflect the skin flaps.

2. At the back of the neck and trunk, note the **posterior rami of the cervical, thoracic** and **lumbar nerves**, which may be accompanied by small vessels. These will be seen piercing the deep fascia about 3–4 cm from the midline.

3. *Remove the superficial and deep fasciae to expose the first layer of muscles of the back of the trunk* i.e. **trapezius** and **latissimus dorsi**. Note the origin of the trapezius from the **occipital bone** to the **spine** of the twelfth **thoracic vertebra**, and its insertion into the **clavicle, acromion process** and the **crest of the spine of the scapula**. Similarly *define the origin of the latissimus dorsi* from the lower thoracic spines, **thoracolumbar fascia, iliac crest**, lower ribs and **inferior angle of the scapula**, and its insertion into the **intertubercular groove of the humerus**.

4. *Divide the trapezius vertically about 2 cm from the midline working from below upwards to the level of the horizontal skin incision* (d). *Clean and preserve the descending* **accessory nerve** entering the deep surface of the lateral portion of the divided muscle. *Then cut the trapezius horizontally along the skin incision* (d) *and from its attachment to the clavicle and acromion and turn the lower cut part of the trapezius laterally*.

5. Note the second layer of muscles lying deep to the trapezius. They are from above downwards (a) **levator scapulae**, (b) **rhomboid minor**, and (c) **rhomboid major**. They are inserted serially along the medial border of the scapula *above, at* and *below* the spine. *Divide the three muscles close to the* **medial border of the scapula**.

6. *Clean the* **deltoid muscle** arising from the anterior aspect of the lateral third of the clavicle, lateral border of the **acromion** and the crest of the spine of the scapula. Note the insertion of the muscle into the **deltoid tuberosity** of the humerus. *Examine* the direction of the anterior, middle and posterior fibres of the muscle.

7. *Cut the deltoid muscle close to its origin and push the muscle downwards and secure the* **axillary nerve** *lying on its deep surface*. It supplies the deltoid and **teres minor** muscles.

8. *Identify the* **subacromial bursa** situated partly below the acromion process and partly below the **coracoacromial ligament** (arch). Deep to the bursa is the supraspinatus tendon.

9. *Clean the* **supraspinatus** *and* **infraspinatus muscles** arising from the **supra-** and **infraspinous fossae** of the scapula. They are inserted into the upper and middle facets on the **greater tubercle of the humerus**. These two muscles are supplied by the **suprascapular nerve**.

10. *Divide the latissimus dorsi vertically below the inferior angle of the scapula and separate the two parts of the muscle*. The three muscles attached along the **axillary** (lateral) **border of the scapula** can now be seen. These are from below upwards: the **teres major, teres minor** and **long head of triceps**.

11. *Feel the origin of the* **subscapularis muscle** on the anterior surface of the scapula and its insertion into the **lesser tubercle of the humerus**. *Quickly review the insertions of the* supraspinatus, infraspinatus, teres minor and subscapularis tendons. Note their intimate relationship to the capsule of the shoulder joint thus forming the **rotator cuff**.

12. *Examine the slips of origin of serratus anterior* passing from the upper eight ribs to the whole length of the medial border of the scapula, the last four slips passing to the inferior angle. *Divide the serratus anterior vertically along the medial border of the scapula.*

13. *Cut though the middle of the clavicle with a saw*.

14. *Next remove the upper limb by cutting the remaining structures close to the first rib*. The upper limb is now free.

Back of Arm

15. *In order to examine the radial nerve* which gives branches to the **long, lateral** and **medial heads of the triceps muscle**, *cut the long head of triceps close to its origin from the* **infraglenoid tubercle of the scapula** *and displace it medially. Follow the radial nerve distally* between the lateral and medial heads of the triceps where it enters the **groove for the radial nerve** on the posterior surface of the humerus. *Detach the lateral head of triceps from its origin from the upper part of the posterior surface of the humerus*. The medial head arises from the posterior surface of the humerus below the groove. Note that the radial nerve supplies also the **anconeus muscle**, which is situated behind and lateral to the elbow joint.

16. *Define the common insertion of the triceps on the* **olecranon process** of the ulna.

17. *Follow the radial nerve* from the groove for the radial nerve towards the lateral side of the arm where it pierces the lateral intermuscular septum. *Observe* that the nerve subsequently lies on the brachialis and is overlapped by the **brachioradialis** and **extensor carpi radialis longus**. The radial nerve supplies all three muscles. *Observe* the division of the radial nerve into **superficial** and **deep branches** just above the elbow.

Summary

The muscles of the back of the trunk are arranged in layers. The superficial two layers are chiefly concerned in attaching the upper limb girdle to the trunk. Consequently the majority of the muscles such as the trapezius, rhomboids and levator scapulae act only on the shoulder girdle. However, the latissimus dorsi, which passes from the trunk to the humerus, has actions both on the girdle and the shoulder joint.

The different parts of the trapezius may act together or independently. Thus the upper fibres of the muscle may act independently in shrugging

the shoulder, or they may act in concert with the lower fibres as in rotating the scapula so that the glenoid cavity faces upwards and forwards during abduction of the arm. Although the trapezius produces the latter action, it is the serratus anterior that is the chief muscle involved in rotating the inferior angle of the scapula outwards and upwards. This muscle also holds the scapula to the thoracic wall during the excursions of this bone which is acted upon by a number of muscles attached to it.

In the back of the arm, the radial nerve gives off most of its branches before it enters the groove for the radial nerve of the humerus, while only the lower lateral cutaneous nerve of arm and the posterior cutaneous nerve of forearm are given off as the nerve lies in the groove. Since the nerve is intimately related to the bone in this part of its course, fractures of the humerus about the middle of the shaft may damage the nerve. However, in the resultant paralysis, the triceps is unaffected.

The axillary nerve may be injured in dislocation of the shoulder joint and in fractures of the surgical neck of the humerus with resultant loss of abduction of the arm.

Objectives for Dissection Schedule 3

SUPERFICIAL DISSECTION OF BACK OF TRUNK, SCAPULAR REGION AND BACK OF ARM

General objective 1

Comprehend the arrangements of the muscles of the regions.

Specific objectives:

1. Define the attachments of the first and second layers of the back muscles.
2. Define the attachments of the muscles on the ventral and dorsal surfaces of scapula.
3. Define the attachments of the muscles on the medial and lateral borders of the scapula.
4. Define the three heads of the triceps brachii and its actions.
5. Illustrate the boundaries of the quadrangular space and the structures passing through it.

General objective 2

Comprehend the arrangements of the nerves and blood vessels of the regions.

Specific objectives:

1. Appreciate the segmental innervation of the skin of the back of the trunk by dorsal rami.
2. Explain the significance of the innervation of most of the scapular muscles by the posterior divisions of the brachial plexus.
3. Discuss the clinical importance of the segmental nerve supply of the elbow joint.
4. Surface mark the radial and axillary nerves in the arm.
5. Deduce the effects of lesion of: (a) the axillary nerve in fracture of the neck of the humerus; and (b) the radial nerve in a mid-shaft fracture.

Overview of Schedule 4

Before you begin dissection note:

JOINTS OF THE SHOULDER REGION

Sternoclavicular Joint

Relevant skeletal features:

manubrium; medial end of clavicle; first costal cartilage.

Muscles in relation to capsule of joint:

pectoralis major; sternocleidomastoid; subclavius.

Capsule:

attachments.

Ligaments:

anterior and posterior sternoclavicular; interclavicular; costoclavicular.

Synovial membrane:

reflection.

Intraarticular structures:

articular disc.

Articular surfaces:

size of sternal and clavicular articular surfaces.

Movements:

gliding; rotation.

Nerve supply:

medial supraclavicular; nerve to subclavius.

Acromioclavicular Joint

Relevant skeletal features:

lateral end of clavicle; acromion process of scapula.

Muscles in relation to capsule of joint:

trapezius; deltoid.

Capsule:

attachments.

Ligaments:

coracoclavicular.

Synovial membrane:

reflection.

Intraarticular structures:

articular disc sometimes present.

Movements:

gliding; rotation.

Nerve supply:

suprascapular; lateral pectoral.

Clinical anatomy:

dislocation.

Shoulder Joint

Relevant skeletal features:

glenoid cavity; head of humerus.

Muscles in relation to capsule of joint:

deltoid; rotator cuff muscles; long head of biceps; long head of triceps.

Capsule:

attachments.

Ligaments:

coracoacromial; coracohumeral; glenohumeral.

Intracapsular structures:

tendon of long head of biceps.

Synovial membrane:

reflection.

Articular surfaces:

humeral and glenoidal articular surfaces; labrum glenoidale.

Movements:

flexion; extension; abduction; adduction; medial and lateral rotation; circumduction.

Nerve supply:

suprascapular; axillary; lateral pectoral.

Clinical anatomy:

dislocation.

BACK OF FOREARM AND HAND

Relevant skeletal features:

humerus — medial and lateral supracondylar ridges
radius — posterior surface; dorsal tubercle; styloid process;
ulna — supinator crest; posterior surface; head; styloid process;
carpus; metacarpus and phalanges.

Subcutaneous structures:

posterior cutaneous nerve of forearm; superficial branch of radial nerve; dorsal branch of ulnar nerve.

Deep fascia:

extensor retinaculum; osteofascial compartments.

Muscles:

brachioradialis; extensor carpi radialis longus and brevis; extensor digitorum; extensor digiti minimi; extensor carpi ulnaris; supinator; abductor pollicis longus; extensor pollicis longus; extensor indicis.

Nerves:

deep branch of radial; posterior interosseous.

Arteries:

posterior interosseous; dorsal carpal arch and branches.

Veins:

dorsal venous arch; basilic and cephalic veins.

Clinical anatomy:

radial nerve palsy; fracture of lower end of radius (Colles' fracture).

Dissection Schedule 4

JOINTS OF SHOULDER REGION AND BACK OF FOREARM AND HAND

Examine the joints of the shoulder girdle:

1. The **sternoclavicular joint:** *Detach the tendinous* **sternal head** *of the* **sternocleidomastoid muscle**. Note the capsule. *Detach the subclavius from its costal origin. Look for the important* **costoclavicular ligament** that extends from the inferior surface of the medial end of the clavicle to the first rib and costal cartilage. This is an accessory ligament of the joint. It prevents excessive forward and backward movement and also upward displacement of the medial end of the clavicle. *Cut downwards through the upper part of the capsule close to the sternum and carefully pull the clavicle laterally* to see the **articular disc**. Note that the disc is attached to the upper part of the medial end of the clavicle above, to the first costal cartilage below, and anteriorly and posteriorly to the capsule.
2. *Now continue to work on the free upper limb*.
3. The **acromioclavicular joint:** Note this joint and its capsule. *Look for the* **coracoclavicular ligament** stretching between the inferior surface of the clavicle and the superior surface of the **coracoid process**. This ligament is an accessory ligament. *Observe* the **coracoacromial ligament** extending from the horizontal part of the coracoid process to the apex of the **acromion process**.
4. The **shoulder joint:** *Define the capsule* and note the tendons of the rotator cuff which are fused to it. *Cut the subscapularis medial to its insertion, reflect the two parts and identify the* **subscapular bursa** *deep to the subscapularis tendon* and note that it communicates with the shoulder joint. *Detach the short head of biceps and coracobrachialis from their origin on the coracoid process. Identify the tendon of the long head of the biceps lying deep to the* **transverse humeral ligament** which stretches across the upper part of the **intertubercular groove**. Note that the **coracohumeral ligament** extends from the root of the coracoid process (above the **supraglenoid tubercle)** towards the **greater tubercle of the humerus**. This strengthens the upper part of

the capsule. Observe the laxity of the **capsule** of the joint and note its attachment to the **anatomical neck** of the humerus except inferiorly where it passes down for 1 cm on to the shaft of the bone. This is the weakest and least protected part of the capsule. *Carefully cut the remaining rotator cuff muscles around the shoulder joint.*

(a) *Make a vertical incision through the posterior part of the capsule and rotate the head of the humerus medially. Try to view the* **glenohumeral ligaments** passing from the anterior margin of the **glenoid cavity** towards the anatomical neck of the humerus. *Now cut through the anterior part of the capsule and identify the origin of the long head of the biceps* from the supraglenoid tubercle of the scapula. Note the difference in the size of the humeral and scapular articular surfaces.

(b) *Identify the* **labrum glenoidale** attached to the margins of the glenoid cavity.

BACK OF FOREARM AND HAND

1. *Now make the following incisions on the posterior aspect of the forearm and hand:*
   (a) *a median incision from the middle of the forearm down to the root of the middle finger;*
   (b) *a transverse incision across the wrist;*
   (c) *a curved incision at the level of the heads of the metacarpal bones; and*
   (d) *a longitudinal incision along the middle of each digit to the nail bed;*

   Reflect the skin flaps.

2. *Clean the* **dorsal venous arch** which lies over the posterior aspect of the metacarpal region and note the commencement of the **basilic** and **cephalic veins** from the ulnar and radial sides of the arch respectively.

3. Note that the **dorsal branch of the ulnar nerve** pierces the deep fascia above the wrist on the medial side of the forearm. This nerve supplies the medial one and a half digits. The **superficial branch of the radial nerve** supplies the remaining digits. It can be seen in the lower lateral part of the forearm.

4. *Define the* **extensor retinaculum** which is attached to the lower end of the **radius** laterally and the **pisiform** and **triquetral** medially. It retains the tendons in their position. *Remove the deep fascia and open the extensor retinaculum with a scalpel*.

5. *Define the three marginal muscles of the forearm*: (a) **brachioradialis** arising from the upper part of the **lateral supracondylar ridge** of the humerus and gaining insertion into the lower lateral end of the radius; (b) **extensor carpi radialis longus** passing from the lower part of the lateral supracondylar ridge to the base of the second metacarpal bone; (c) **extensor carpi radialis brevis** extending from the **lateral epicondyle of the humerus** to the base of the third metacarpal. Note, once again, the nerve supply from the trunk of the **radial nerve** to the first two muscles and to the extensor carpi radialis brevis from the **deep branch of the radial nerve** which you will see later.

6. *Now examine the three superficial extensors*: (a) **extensor digitorum**; (b) **extensor digiti minimi**; and (c) **extensor carpi ulnaris**. These three muscles have a common origin from the lateral epicondyle of the humerus. *Trace the extensor digitorum into the hand* where it splits into four tendons for the medial four digits. Note that the extensor digiti minimi fuses with the extensor digitorum tendon for the little finger. *Next trace the extensor carpi ulnaris to its insertion into the base of the fifth metacarpal bone.*

7. *Divide the extensor digitorum, extensor digiti minimi and extensor carpi ulnaris midway between their origin and insertion to bring into view the deep group of five muscles. Study their attachments and follow them to their insertion*. From above downwards, these are:
   (a) the **supinator**, passing from the lateral epicondyle of the humerus and **supinator crest of the ulna** to the upper third of the radius. Note how the muscle winds round the posterior surface of the radius;
   (b) **abductor pollicis longus** taking origin from the upper posterior surfaces of both radius and ulna, and gaining insertion into the base of the first metacarpal;
   (c) **extensor pollicis brevis** arising from the posterior surface of the radius and inserting into the base of the proximal phalanx of the thumb;

   Observe that the tendons of the last two muscles run side by side on the lateral aspect of the wrist;

(d) **extensor pollicis longus** taking origin from the posterior surface of the ulna and gaining insertion into the base of the terminal phalanx of the thumb; note that the tendon passes medial to the **dorsal tubercle of the radius** on the posterior aspect of the distal end of the radius; and

(e) **extensor indicis** originating from the lower part of the posterior surface of the ulna and fusing with the extensor digitorum tendon for the index finger.

8. *Trace the deep branch of the radial nerve through the supinator* and note that it continues as the **posterior interosseous nerve**. In its lower part, the nerve accompanies the **posterior interosseous artery**. The posterior interosseous nerve supplies the superficial and deep extensor muscles.

9. *Again trace the extensor tendons as they pass under the extensor retinaculum*. Note that they lie in their separate osteofascial compartments. As they lie in these compartments, they are covered by **synovial sheaths**.

10. *Identify once again the tendons of the extensor digitorum*. Note that the tendons to the index and little fingers are joined by the tendons of the extensor indicis and extensor digiti minimi respectively. *Observe* that the tendons begin to expand towards the digits where they form the **extensor expansions**. These expansions also receive contributions from the **lumbrical** and **interossei** muscles in the hand. *Trace the slips from the expansions to their insertions into the bases of the intermediate and distal phalanges*.

11. *Near the wrist find the* **radial artery** passing backwards beneath the tendons of the abductor pollicis longus, extensor pollicis brevis and extensor pollicis longus to enter the palm from behind between the two heads of the **first dorsal interosseous muscle** in the first intermetacarpel space.

Summary

The **sternoclavicular joint**, though classified as a saddle joint, permits varying types of movements of the clavicle such as elevation, depression, forward and backward movements as well as rotation. The strength of this joint depends largely on the strength of the ligaments. In particular, the

costoclavicular ligament and the interarticular disc check the upward displacement of the medial end of the clavicle. Consequently, dislocation of the medial end of the clavicle does not usually occur.

The **shoulder joint** is a ball and socket joint in which mobility is greatly increased at the expense of stability. The strength of the joint depends chiefly on the rotator cuff muscles that are fused to the capsule of the joint. The joint is least protected inferiorly and consequently dislocations commonly occur here.

The *plane of the joint* is set obliquely so that the arm is carried forwards and medially during flexion and backwards and laterally during extension. Abduction is initiated by the supraspinatus and further carried out by the deltoid. As abduction proceeds towards a vertical position, the humerus is rotated laterally.

It must also be borne in mind that during movements of the shoulder joint, simultaneous movements occur at the sternoclavicular and acromioclavicular joints. Consequently, any restriction of movements of these joints will indirectly affect the movements of the shoulder joint. Moreover, movements of the shoulder joint are assisted by an excursion of the scapula on the thoracic wall. Therefore, any paralysis of muscles which moves the scapula will restrict the range of movement at the shoulder joint. Indeed, in abduction of the arm through a possible 180⊇ scapular rotation by itself contributes to about a third of the total movement.

The muscles of the back of the forearm can be classified into superficial and deep groups. The *superficial* set comprises the brachioradialis, extensor carpi radialis longus and brevis which are situated laterally (marginal group) and the extensor digitorum, extensor digiti minimi and extensor carpi ulnaris which occupy the dorsal aspect of the forearm. The *deep group* is formed by the supinator, abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus and the extensor indicis. All these muscles are supplied by the radial nerve or its branches. Consequently, in cases of injury to the radial nerve, the extensor muscles will be paralysed leading to a condition known as **wrist drop**.

Objectives for Dissection Schedule 4

1. JOINTS OF THE SHOULDER GIRDLE

General objective 1

Comprehend the arrangement of the osteoligamentous structures of the joints of the shoulder girdle.

Specific objectives:

1. Orientate the sternum, clavicle, scapula and humerus.
2. Articulate the clavicle with the sternum and first costal cartilage and compare the clavicular and sternal articular surfaces.
3. Describe the ligaments of the sternoclavicular joint.
4. Assign a functional role to the articular disc of the sternoclavicular joint.
5. Articulate the clavicle with the acromion.
6. Describe the ligaments of the acromioclavicular joint.
7. Assign the functional role to the coracoclavicular ligament.
8. Articulate the humerus with the scapula.
9. Compare the articular surfaces of the shoulder joint.
10. Describe the attachments of the capsular, transverse and coracohumeral ligaments of the shoulder joint.
11. Identify the anatomical and the surgical neck of the humerus.
12. Define the axes and movements of the shoulder joint.
13. Discuss the stability of the shoulder joint.
14. Analyse the innervation of the shoulder joint based on Hilton's law.
15. Explain how movements of the shoulder joint are associated with movements of the acromioclavicular and sternoclavicular joints.
16. Interpret X-rays of these joints.

General objective 2

Comprehend the arrangement of the muscles acting on the joints of the shoulder girdle.

Specific objectives:

1. Classify the muscles acting on the shoulder joint into flexors, extensors, abductors, adductors and rotators.
2. Outline the role of the rotator cuff muscles.
3. Explain the effects of paralysis of the deltoid, supraspinatus and serratus anterior.
4. Explain the role of serratus anterior, trapezius, rhomboids and levator scapulae in scapular rotation.

2. BACK OF THE FOREARM AND HAND

General objective 1

Understand the disposition of the muscles in the region.

Specific objectives:

1. Enumerate the muscles of the superficial and deep extensor groups.
2. Define the osteofascial compartments on the back of the wrist and enumerate the tendons passing through each compartment.
3. Define the formation and termination of the extensor expansions to each digit.
4. Comment on the tendons to the thumb, index finger and little finger.

General objective 2

Comprehend the arrangement of the nerves and blood vessels of the region.

Specific objectives:

1. Define the muscles supplied by the radial nerve and its branches.
2. Indicate the segmental innervation of the wrist joint and the joints of the fingers.
3. Explain wrist drop in anatomical terms.
4. Analyse the cutaneous innervation and dermatomic pattern of the region.
5. Trace the origin, course and termination of the basilic and cephalic veins.

Overview of Schedule 5

Before you begin dissection note:

FRONT OF FOREARM AND HAND

Relevant skeletal features:

humerus — medial epicondyle; medial supracondylar ridge;
radius — head; surfaces; borders; styloid process;
ulna — surfaces; borders; head; styloid process;
carpus — hook of hamate; tubercle of scaphoid; pisiform; tubercle of trapezium; metacarpus; phalanges.

Subcutaneous structures:

medial cutaneous nerve of forearm; lateral cutaneous nerve of forearm; palmar cutaneous branch of ulnar nerve; palmar cutaneous branch of median nerve; digital nerves and vessels; cephalic, basilic and median cubital veins.

Deep fascia:

flexor retinaculum; palmar aponeurosis; fascial septa of the hand; fibrous flexor sheaths.

Ligaments:

deep transverse metacarpal ligaments.

Muscles:

flexor carpi ulnaris; palmaris longus; flexor carpi radialis; pronator teres; flexor digitorum superficialis; flexor digitorum profundus; flexor pollicis longus; pronator quadratus; thenar and hypothenar muscles; lumbricals; adductor pollicis; interossei.
Synovial sheaths of long flexor tendons.

Nerves:

median; ulnar; superficial radial.

Arteries:

radial and ulnar arteries and their branches; superficial and deep palmar arches.

Surface anatomy:

radial and ulnar arteries; median nerve near the wrist.

Clinical anatomy:

Volkmann's ischaemic contracture; Dupuytren's contracture; fascial spaces of hand.

Dissection Schedule 5

FRONT OF FOREARM AND HAND

1. *Make the following incisions on the anterior aspect of the forearm and hand:*
   (a) *a median incision from the middle of the forearm to the root of the middle finger;*
   (b) *a transverse incision across the wrist;*
   (c) *a curved incision across the roots of all five digits; and*
   (d) *a longitudinal incision along the middle of each digit down to its distal end.*

   Reflect the skin flaps.

2. *Clean the portions of the* **cephalic** *and* **basilic veins** *in the front of the forearm.*

3. *Clean the deep fascia of the forearm and define the* **flexor retinaculum** *at the wrist;* this is a thick, quadrangular band of deep fascia bridging the **carpal tunnel**. This will be examined later.

4. *Expose the superficial group of muscles of the forearm by removing the deep fascia* which not only covers them but also gives them partial origin. From lateral to medial, these muscles are the **superficial head of the pronator teres, flexor carpi radialis, palmaris longus** and the **flexor carpi ulnaris**. All of these arise from the **medial epicondyle of the humerus**, the common flexor origin, except the superficial part of the pronator teres which has its origin from the **medial supracondylar ridge**.

5. *Trace the flexor carpi ulnaris tendon from the common flexor origin and from the upper part of the posterior border of the ulna to the* **pisiform bone**. The slender palmaris longus passes distally to insert into the flexor retinaculum and **palmar aponeurosis**. This muscle may be absent. The flexor carpi radialis runs towards the flexor retinaculum where it passes through the retinaculum in a separate compartment to insert into the bases of the second and third metacarpal bones (see later). The **pronator teres** is a short muscle which runs laterally and downwards to be inserted into the middle of the lateral side of the shaft of the radius.

6. *Cut the superficial group of muscles about the middle of their muscle bellies and reflect them*. The nerve supply to the pronator teres, flexor carpi radialis and palmaris longus comes from the **median nerve**. The flexor carpi ulnaris is supplied by the **ulnar nerve**. *Verify* that the ulnar nerve runs *behind* the medial epicondyle and enters the forearm between the two heads of the flexor carpi ulnaris.

7. *Identify the* **flexor digitorum superficialis** *and the* **deep head of the pronator teres** which lie deep to the superficial group of muscles. *Preserve the median nerve* as it passes down between the two heads of the pronator teres and deep to the flexor digitorum superficialis. The latter muscle has a broad origin from the medial epicondyle of the humerus, **coronoid process of the ulna** and **anterior border of the radius**. Note the fibrous arcade which overlies the median nerve and ulnar artery as they pass deep to this muscle. *Observe the tendons of the superficialis as they lie near the wrist* and note that they pass to the **index, middle, ring** and **little fingers**.

8. *Identify the median nerve* just proximal to the flexor retinaculum, emerging from beneath the flexor digitorum superficialis and lying between the tendons of palmaris longus and flexor carpi radialis.

9. *Cut the flexor digitorum superficialis muscle in its middle and reflect the two parts*. Note the innervation from the median nerve. *Observe* that the neurovascular structures comprising the median nerve, ulnar artery and ulnar nerve lie on the deep group of muscles.

10. *Trace the* **ulnar artery**, which runs downwards from the cubital fossa, deep to the deep head of the pronator teres, towards the medial side of the wrist where it lies *superficial* to the **flexor retinaculum**. The artery gives off numerous branches, the most important being the **common interosseous artery**, which arises at the level of the radial tuberosity high up in the forearm and divides into **anterior** and **posterior interosseous branches**.

11. *Define the central part of the palmar aponeurosis* which lies immediately deep to the skin of the palm and trace the four slips passing from it to the roots of the medial four fingers. *Trace the* **digital branches** *of the median and ulnar nerves* as they pass down between these slips accompanied by digital arteries.

12. *Examine the* flexor retinaculum which is attached laterally to the **tubercle of the scaphoid** and the tubercule of the **trapezium** and medially to the pisiform and **hook of the hamate**. Note the **palmaris brevis**, a small subcutaneous muscle running transversely from the retinaculum towards the **hypothenar eminence** and *remove it. Identify the ulnar nerve and artery lying superficial to the flexor retinaculum.*

13. *Carefully reflect the palmar aponeurosis downwards and avoid damaging the deeper structures*. Note the fascial septa passing from the palmar aponeurosis to the first and fifth metacarpal bones and separating the flexor tendons from the **thenar** and **hypothenar muscles**.

14. *Next trace the distal part of the ulnar artery into the palm* where it continues as the **superficial palmar arch** which lies in front of the superficial tendons. This arch is reinforced laterally by the **palmar branch of the radial artery**. *Note that lateral to the pisiform bone the ulnar artery gives off a small* **deep palmar branch** *which accompanies the* **deep branch of the ulnar nerve**. The superficial palmar arch gives off four **common palmar digital branches** to the medial three and a half digits. The radial side of the index and both sides of the thumb are supplied by the radial artery (see later).

15. *Trace the ulnar and median nerves from the wrist into the palm where the origin of their digital branches can be seen*. Note that the median nerve reaches the palm *deep* to the flexor retinaculum by passing through the carpal tunnel. The nerve supplies the three thenar muscles.

16. *Clean the thenar muscles. Identify the laterally placed* **abductor pollicis brevis** *and the more medially situated* **flexor pollicis brevis**. Note the origin of both these muscles from the flexor retinaculum, the scaphoid and the trapezium. Both are inserted into the lateral side of the base of the **proximal phalanx** of the thumb. *Trace their nerve supply from the median nerve. Cut the two muscles in the middle and reflect them and define the more deeply placed* **opponens pollicis** passing from the flexor retinaculum and trapezium to the shaft of the **first metacarpal bone**.

17. *Next turn your attention to the hypothenar muscles. Identify and cut the* **abductor digiti minimi** *and* **flexor digiti minimi brevis** *in the middle and identify the deeper* **opponens digiti minimi** *muscle*. They

arise from the flexor retinaculum, the pisiform bone and from the hook of the hamate. *Identify the insertions of the abductor and flexor into the medial side of the base of the proximal phalanx of the fifth digit and the opponens into the shaft of the fifth metacarpal bone*. The nerve supply to these muscles comes from the deep branch of the ulnar nerve which passes between the abductor and flexor digiti minimi to enter the deep aspect of the palm. Note that the branch is accompanied by the deep palmar branch of the ulnar artery. *Try to find them*.

18. *Now clean the following deep structures on the front of the forearm:*
    (a) laterally **flexor pollicis longus muscle** arising from the anterior surface of the radius and interosseous membrane;
    (b) medially **flexor digitorum profundus muscle** arising from the interosseous membrane as well as from the anterior and medial surfaces of the ulna;
    (c) below **pronator quadratus muscle** extending between the distal fourth of the ulna and radius and lying deep to the deep flexor tendons. It is the principal pronator; and
    (d) the **anterior interosseous nerve** from the median nerve supplying the above three muscles with the exception of the medial part of flexor digitorum profundus which receives its innervation from the ulnar nerve. The anterior interosseous nerve lies on the interosseous membrane between flexor digitorum profundus and flexor pollicis longus and terminates in the pronator quadratus. The nerve is accompanied by the anterior interosseous artery.

19. *Trace the radial artery deep to the brachioradialis. Divide the brachioradialis muscle in its middle and reflect it so as to identify the artery and the accompanying superficial branch of the radial nerve. Follow the radial artery* down to the **styloid process of the radius**. Note the structures on which this artery lies. Its branches in this region are:
    (a) the **superficial palmar artery** arising above the wrist and descending to join the superficial palmer arch;
    (b) the **arteria princeps pollicis** which supplies the thumb;
    (c) the **arteria radialis indicis** which supplies the index finger; and
    (d) branches to the neighbouring muscles.

20. *Make a vertical incision down the middle of the flexor retinaculum. Observe* the arrangement of the tendons of the flexor digitorum

superficialis, flexor digitorum profundus, flexor pollicis longus and flexor carpi radialis as they pass under the retinaculum and the relationship of the median nerve to these tendons. *Below the retinaculum identify the four* **lumbrical muscles** arising from the tendons of the flexor digitorum profundus. These muscles are inserted into the radial side of the extensor expansion. Note that the medial two lumbricals receive their innervation from the deep branch of the ulnar nerve and the lateral two lumbricals from the median nerve.

21. Note that the tendons of the flexors digitorum superficialis and profundus are covered by **synovial sheaths** . *Trace these tendons from the palm to one of the digits by incising the* **fibrous flexor sheath** *covering them. You will see* that the superficialis tendon *splits* into two bundles which pass around the profundus tendon and insert *into the sides* of the **middle phalanx** and that the profundus tendon inserts into the **base of the distal phalanx**. *Then trace the flexor pollicis longus to its insertion into the base of the distal phalanx of the thumb. Next cut the tendons of the flexor digitorum profundus and flexor pollicis longus just above the wrist, and turn them and the superficialis tendons downwards. Also cut through the middle of the superficial palmar arch and the accompanying nerve so as to get a better view of the deep aspect of the palm.*

22. *Now turn your attention to the deep intrinsic group of muscles which lie deep to the flexor tendons. Clean the* **adductor pollicis**. Its **transverse head** arises from the shaft of the third metacarpal bone while its **oblique head** arises from the bases of the second and third metacarpals and **capitate**. Both heads are inserted into the medial side of the base of the proximal phalanx of the thumb. Note that the potential **fascial spaces (palmar spaces)** of the hand are situated deep to the flexor tendons and superficial to the adductor pollicis and **interossei**.

23. *Identify the radial artery* emerging between the transverse and oblique heads of the adductor pollicis. *Reflect the oblique head from its origin. Observe* that the **deep palmar arch** is formed by the continuation of the radial artery and the deep branch of the ulnar artery. Note the **palmar metacarpal arteries** arise from the deep palmar arch and join the digital branches from the superficial palmar arch.

24. *Clean the deep branch of the ulnar nerve* which supplies the medial two lumbricals, adductor pollicis and all the interossei muscles. *Reflect the transverse head of adductor pollicis from its origin*. Note that the **four palmar interossei** arise from the corresponding metacarpal bones and the **four dorsal interossei** from the adjacent metacarpal bones. The palmar interossei are inserted into the extensor expansion, and the dorsal interossei are inserted into the bases of the proximal phalanges and the extensor expansion. Primarily, all the interossei and the lumbricals are *flexors* of the metacarpophalangeal joints, in addition the palmar interossei *adduct* the digits towards the middle finger and the dorsal interossei *abduct* the digits and the middle finger. As a consequence of their insertions into the extensor expansions, these three sets of muscles are able to *extend* the middle and distal phalanges under certain conditions.

Summary

The muscles of the front of the forearm can be subdivided into: (a) those muscles passing to the digits, i.e. digital flexors; and (b) those concerned with flexion of the wrist. The tendons of the flexor digitorum superficialis are inserted into the middle phalanges, whereas those of the flexor digitorum profundus and flexor pollicis longus gain insertion into the distal phalanges. It is noteworthy that the presence of separate flexor tendons for the middle and distal phalanges increases the grasping efficiency of the hand. The actions of these slips on the interphalangeal joints are opposed by the slips of insertion of the extensor expansions. However, the action of the flexors is more powerful than that of the extensors.

The presence of a separate flexor pollicis longus for the thumb and an early separation of the tendon from the flexor digitorum profundus to the index finger provide a greater degree of freedom of movement to these digits. There is a similar specialisation of the extensor tendons for the thumb and index finger.

The flexor carpi radialis and flexor carpi ulnaris are usually flexors of the wrist. But they can also function together with their corresponding antagonistic extensors in producing radial or ulnar deviation of the wrist.

For example, the flexor and the extensor carpi ulnaris act together in producing ulnar deviation of the wrist.

The thenar muscles of the hand also exhibit a certain amount of specialisation. The large size of the opponens pollicis and the presence of a special adductor for the thumb are features peculiar to the thumb. Moreover, the thumb is capable of rotation so that its palmar surface can be opposed towards the pulps of the other digits.

The *muscles of the front of the forearm* are innervated by the median nerve or its anterior interosseous branch except the flexor carpi ulnaris and the medial portion of the flexor digitorum profundus which receive their nerve supply from the ulnar nerve. The *intrinsic muscles of the hand* are supplied by the ulnar nerve except the thenar muscles and the lateral two lumbricals which are innervated by the median nerve. *The nerves which supply the intrinsic muscles of the hand are derived from the T1 segment of the brachial plexus*.

The median nerve may be compressed within the carpal tunnel, giving rise to the **carpal tunnel syndrome**. Similarly the ulnar nerve may be compressed as it lies behind the medial epicondyle of the humerus. Damage to the median nerve produces a condition known as the **simian hand** while damage to the ulnar nerve produces a **claw hand**.

The radial and ulnar arteries are the principal vessels of the forearm. In their course, they lie between the radial and ulnar nerves. The ulnar artery continues as the superficial palmar arch while the radial artery continues into the more proximally situated deep palmar arch.

Objectives for Dissection Schedule 5

FRONT OF FOREARM AND HAND

General objective 1

Comprehend the arrangement of the muscles of the region.

Specific objectives:

1. Enumerate the superficial, intermediate and deep flexors of the forearm.
2. Define the attachments of the superficial group of flexors.
3. Define the attachments and surface mark the flexor retinaculum.
4. Enumerate the order of structures superficial and deep to the retinaculum.
5. Describe the formation of the thenar and hypothenar compartments and their contained muscles.
6. Indicate the actions of the thenar and hypothenar muscles.
7. Define the fibrous flexor sheaths, synovial sheaths and terminations of long flexor tendons.
8. Describe the origins and insertions of the lumbricals and interossei.
9. Outline the actions of the flexor, lumbrical and interossei muscles.

General objective 2

Comprehend the arrangement of the nerves and blood vessels of the region.

Specific objectives:

1. Define the neurovascular plane of the forearm.
2. Describe the course and distribution of the radial and ulnar arteries.
3. Demonstrate the formation of the superficial and deep palmar arches and surface-mark them.
4. Analyse the nerve supply to the flexor compartment of the forearm.

5. Define the dermatomic pattern of the region.
6. Deduce the effects of lesion of the ulnar and median nerves at the elbow and wrist.
7. Discuss the importance of the arrangement of the digital vessels and nerves in local anaesthesia.
8. Recognise the clinical importance of the palmar spaces.

Overview of Schedule 6

Before you begin dissection note:

JOINTS OF FREE UPPER LIMB

Elbow Joint

Relevant skeletal features:

humerus	—	trochlea; capitulum; radial, coronoid and olecranon fossae;
ulna	—	trochlear notch; coronoid and olecranon processes;
radius	—	head; neck; tuberosity.

Muscles in relation to capsule of joint:

brachialis; biceps; triceps; anconeus.

Capsule:

attachments.

Ligaments:

ulnar collateral; radial collateral.

Synovial membrane:

reflection.

Articular surfaces:

shape; carrying angle.

Movements:

flexion; extension.

Nerve supply:

musculocutaneous; radial.

Blood supply:

anastomosis around elbow.

Clinical anatomy:

dislocations; fractures.

Proximal, Middle and Distal Radioulnar Joints

Relevant skeletal features:

radius — head; ulnar notch; interosseous border;
ulna — radial notch; head; interosseous border.

Capsule:

attachments.

Ligaments:

anular (proximal joint).
interosseous membrane.

Intraarticular structures:

articular disc (distal joint).

Synovial membrane:

reflection.

Movements:

pronation; supination; axis of movement.

Wrist Joint

Relevant skeletal features:

distal end of radius; articular disc; scaphoid; lunate; triquetrum.

Capsule:

attachments.

Ligaments:

palmar radiocarpal and palmar ulnocarpal; dorsal radiocarpal and dorsal ulnocarpal; radial and ulnar collateral.

Synovial membrane:

reflection.

Articular surfaces:

shape.

Movements:

flexion; extension; adduction; abduction; circumduction.

Intercarpal, Midcarpal, Carpometacarpal, Metacarpophalangeal and Interphalangeal Joints

Relevant skeletal features:

carpus; metacarpus; phalanges.

Capsule:

attachments.

Ligaments:

dorsal and palmar; collateral; interosseous.

Synovial membrane:

reflection.

Movements:

flexion, extension (all joints); adduction, abduction (midcarpal joint, metacarpophalangeal joints and carpometacarpal joint of thumb); rotation and circumduction (carpometacarpal joint of thumb).

Dissection Schedule 6

JOINTS OF FREE UPPER LIMB

1. Elbow and Proximal Radioulnar Joints

These joints are described together as they have a common capsule and synovial cavity.

1.1. Note the intimate relationships of the brachialis and triceps muscles to the anterior and posterior parts of the **elbow joint** respectively, and the supinator to the proximal radioulnar joint. *Remove these muscles and then remove the flexor and extensor muscles from their epicondylar origins. Take care so as not to damage the* **capsule of the elbow joint** *and the* **anular ligament**; the latter surrounds the head of the radius and is attached to the margins of the **radial notch of the ulna**.

1.2. *Define the* **ulnar collateral ligament** *of the elbow joint*. This is composed of three distinct bands: **anterior, posterior** and **oblique**. The anterior band passes between the medial epicondyle of the humerus and the coronoid process of the ulna; the posterior band passes between the medial epicondyle and the olecranon process of the ulna; and the oblique band passes between the coronoid and olecranon processes.

1.3. *Define the triangular shaped* **radial collateral ligament** *of the elbow joint* which extends fanwise from the lateral epicondyle to the anular ligament.

1.4. *Observe* that the anterior and posterior parts of the capsule of the elbow joint are weak. *Make a transverse cut through the anterior part of the joint capsule and examine the articular surfaces.*

1.5. Note that the **anular ligament** of the **proximal radioulnar joint** is somewhat funnel-shaped, being wider superiorly. The ligament passes around the head of the radius and is attached to the anterior and posterior margins of the radial notch of the ulna. *Cut through the anular ligament on its lateral aspect and verify its shape*. This joint is part of the elbow joint.

2. Interosseous Membrane

Next examine the **interosseous membrane** which forms a bond between the radius and ulna. *Remove the muscles, nerves and vessels in order to see the interosseous membrane.*

3. Distal Radioulnar and Wrist Joints

These two joints are considered together because the **inferior radioulnar joint** cannot be studied without cutting through the capsule of the **wrist joint**.

3.1. *Review the flexor and extensor tendons related to the wrist joint.*

3.2. *Define the capsule of the wrist joint and observe the* **palmar radiocarpal** *and* **palmar ulnocarpal ligaments**; *the* **dorsal radiocarpal** and **dorsal ulnocarpal ligaments**; *and the* **radial** *and* **ulnar collateral ligaments**.

3.3. *Cut through the dorsal part of the capsule of the wrist joint and expose the articular surfaces. Look at the triangular* **articular disc**, whose apex is attached to the root of the **styloid process of the ulna** and its base to the lower margin of the **ulnar notch of the radius**.

4. Intercarpal, Midcarpal, Carpometacarpal, Metacarpophalangeal and Interphalangeal Joints

4.1. *Remove the muscles related to these joints* and note the **palmar, dorsal** and **intersseous ligaments** at the **intercarpal joints**. *Open the midcarpal joint from the dorsal aspect and examine the articular surfaces*.

4.2. **Carpometacarpal joint of the thumb**. *Examine the loose capsule. Open the capsule posteriorly and examine the shape of the articular surfaces*. What movements are possible at this joint?

4.3. *Next examine the strong* **palmar** *and* **collateral ligaments** *of the* **metacarpophalangeal joints**. Note that the **deep transverse metacarpal ligaments** connect the medial four **palmar ligaments**.

4.4. The **interphalangeal joints**. Note the strong **palmar** and **collateral ligaments**.

Summary

The **elbow joint** is a **hinge joint** in which movements of flexion and extension take place. To facilitate these movements, the anterior and posterior parts of the capsule are thin. However, the collateral ligaments are strong to provide stability to the joint. The axis of movement is not entirely transverse and consequently the forearm tends to deviate outwards to produce the so-called carrying angle when the forearm is fully extended *in the supine*

position. This angle disappears during pronation of the forearm and during flexion of the elbow.

The **radioulnar joints**. The movements occurring at these joints are pronation and supination. The axis for these movements passes through the centre of the head of the radius and the root of the styloid process of the ulna. Pronation and supination are most effective when the elbow is semiflexed. In this position the elbow joint is most stable.

The **wrist joint** is an **ellipsoid joint** in which the articular surface of the carpus extends more on to the dorsal than the palmar aspect. This explains why extension of the wrist is more than flexion. However, it should be noted that movement of the wrist joint involves simultaneous movements at the midcarpal joint. In flexion of the wrist, there is more movement taking place at the midcarpal joint than at the wrist joint. Furthermore, the range of adduction at the wrist is more than abduction.

The **carpometacarpal joint** of the thumb is a **saddle joint** between the trapezium and the first metacarpal bone. *Abduction* and *adduction* occur at right angles to the plane of the palm, while *flexion* and *extension* take place in a plane parallel to the palm. In addition, *rotation* also occurs at this joint.

Opposition of the thumb is the movement whereby the palmar surface of the thumb is brought into apposition with the palmar surfaces of the other digits.

Objectives for Dissection Schedule 6

1. ELBOW JOINT

General objective

Comprehend the arrangement of the osteoligamentous structures of the joint and the disposition of the muscles around it.

Specific objectives:

1. Identify the trochlea; capitulum; coronoid, radial and olecranon fossae of the humerus.
2. Articulate the radius and ulna with the humerus.
3. Demonstrate the attachments of the capsular ligament and the radial and ulnar collateral ligaments.
4. Discuss the muscles involved in flexion and extension.
5. Discuss the clinical importance of segmental innervation of the joint.
6. Indicate the types of dislocation and sites of common fractures around the joint.
7. Interpret X-rays of these conditions as well as those of normal joints.

2. RADIOULNAR JOINTS

General objective

Comprehend the movements of pronation and supination of the forearm.

Specific objectives:

1. Define the articulating surfaces of the proximal and distal radioulnar joints.
2. Demonstrate pronation and supination and the axis for these movements.
3. Discuss the line of pull of the biceps, supinator, pronator teres, pronator quadratus and brachioradialis muscles in relation to this axis.

4. Assign functional roles to the anconeus muscle; anular ligament; articular disc.
5. Discuss the segmental innervation of the joints.
6. Interpret X-rays of the forearm and hand in pronation and supination.

3. WRIST AND MIDCARPAL JOINTS

General objective

Comprehend the structural and functional aspects of the joints.

Specific objectives:

1. Define the articulating surfaces, capsules and synovial reflections of the joints.
2. Enumerate the primary flexors and extensors of the wrist.
3. Identify the tendons around the wrist in the living.
4. Define the movements at the wrist in terms of its ellipsoid articular surfaces.
5. Discuss the range of movements at the wrist and associated movements occurring at the midcarpal joint.
6. Assign functional roles to the muscles acting on the joints in terms of prime movers, antagonists, synergists and fixation muscles.
7. Discuss the segmental innervation of the joints.
8. Interpret X-rays of normal joints and those with fractures around the wrist.

4. SMALL JOINTS OF THE HAND

General objective

Evaluate the functional anatomy of the hand.

Specific objectives:

1. Classify the carpometacarpal joint of the thumb, the metacarpophalangeal and interphalangeal joints according to the shape of the articulating surfaces.

2. Review the modes of insertion of the long flexors and extensors of the forearm; the lumbricals and interossei.
3. Explain the increased freedom of movement of the index and little fingers, and the specialised movements peculiar to the thumb.
4. Comprehend the anatomical basis of power, precision, hook and pinch grips.
5. Demonstrate the position of rest and the working position of the hand.
6. Analyse the contributions of the skin and subcutaneous structures in the performances of manual skills.
7. Outline the segmental innervation of the smaller joints of the hand.
8. Interpret the X-rays of the hand.

Additional Objectives for Upper Limb

1. NERVES OF THE UPPER LIMB

General objective:

Understand the disposition of the nerves of the upper limb and the clinical importance of this knowledge.

Specific objectives:

1. Illustrate the formation of the brachial plexus and its distribution.
2. Demonstrate the ulnar, median, musculocutaneous, radial and axillary nerves, mentioning their root values.
3. Surface mark the above nerves and place them in relation to the relevant bones.
4. Demonstrate tendon jerks and discuss their anatomical basis.
5. Demonstrate the anatomical principles in the testing of sensory loss.
6. Explain the anatomical basis for the causation and manifestation of: Erb's and Klumpke's paralyses; crutch palsy and wrist drop; claw hand; cervical rib and carpal tunnel syndromes.

2. BLOOD VESSELS AND LYMPHATICS OF THE UPPER LIMB

General objective:

Understand the principles of the blood supply and lymphatic drainage.

Specific objectives:

1. Identify the subclavian, axillary, brachial, radial and ulnar arteries.
2. Indicate the extent of these arteries, their surface markings, the points for feeling the pulse and the site for recording blood pressure in the upper limb.
3. Illustrate the concept of the *neurovascular plane*.

4. Illustrate the principles of collateral circulation and periarticular anastomoses.
5. Explain the arrangement of superficial and deep veins.
6. Demonstrate manoeuvres for displaying superficial veins and the presence of valves in them.
7. Define the routes of venous drainage and the extent of the cephalic, basilic, median cubital and axillary veins.
8. Discuss the selection of the cubital fossa as the site for intravenous infusions.
9. Indicate the routes of drainage of superficial and deep lymphatics.
10. Describe the regional lymph nodes and attempt to palpate them in the living.
11. Discuss the anatomical basis of Volkmann's ischaemic contracture and Dupuytren's contracture.

3. SKELETAL FRAMEWORK OF THE UPPER LIMB

General objective:

Understand basic anatomical principles in the study of the bones of the upper limb.

Specific objectives:

1. Exemplify short, long, flat, membrane and cartilage bones using the bones of the upper limb.
2. Describe the ossification of a long bone using the humerus as an example.
3. Discuss common sites of fractures in relation to the line of transmission of stress and the changes in the contour of the bones.
4. Analyse radiographs of long bones in children and adults, pointing out the importance of a sound knowledge of epiphyseal lines and the arrangement of bony lamellae along lines of stress.

5. Discuss the relative importance of periosteal, epiphyseal, metaphyseal and nutrient arteries in the vascularisation of a typical long bone.
6. Discuss the genesis and adult structure of the marrow cavity, and its clinical importance.

4. JOINTS OF THE UPPER LIMB

General objective:

Comprehend the classification of synovial joints.

Specific objectives:

Exemplify the features of a ball and socket, pivot, ellipsoid, plane, condyloid, saddle and hinge joints based on the joints of the upper limb.

5. MUSCLES OF THE UPPER LIMB

General objective:

Comprehend the various actions of groups of muscles in the upper limb.

Specific objectives:

1. Demonstrate the muscle actions in the pectoral, shoulder, arm, forearm and hand regions.
2. Consider the nerve supply of the various muscle groups.