LEARNING OBJECTIVES:

1. Describe the humerus, indicating the sites of muscle attachment.
2. Describe the radius and ulna.
3. Discuss the principle features of the elbow joint.
4. Describe the arm by compartment, including the function, innervation and blood supply of each.
5. Name the muscles flexing the elbow joint, and describe their origin and insertion.
6. Name the muscles extending the elbow and describe their origin and insertion.
7. Trace the courses of the musculocutaneous, median, ulnar and radial nerves through the arm.
8. Describe the pathway of the brachial artery, and indicate points of anastomosis between its branches.
Organizational Notes

My version of the soapbox/pep talk. So far, we have been coasting in this class; the workload and volume of material will, as of today, begin to increase somewhat exponentially. I will make some of you sweat today. This course has lots and lots of stuff to learn in a very short period of time, you must develop effective strategies. Some keys to success and specific advice:

- **Number 1: Do not study things that you already know,** this is an easy trap to fall into because it is comforting. Get out on the edge of your knowledge where it is painful. Study at that point. Also, learn to recognize when you know something and move on, again it is critical to concentrate on learning things that you do not know. *This is the single most important advice that I can provide.*

- Pick a resource that works, don’t try to use them all. We have lots of support services. If you try to learn from every one of them you will become overwhelmed. Pick 1 or 2 that fit your learning style and stick to them, focus your efforts.

- It’s ok to spend long hours studying gross, it’s ok to come back and spend long hours in the dissection lab-we know there is a lot of material and we expect you to spend time going over the material. That is why the lab is open 24/7.

- Ignore the text book unless desperate (or very, very lonely). Concentrate on the lecture notes. Study the dissector and practice questions from the head to toe collection. In the laboratory, do not be bashful talking your way through the language of anatomy. Work as a team, quiz each other when you are around the tables doing the dissections.

- Participate in the dissections. Experience tells us that not physically doing the dissections represents the single best predictor that a student will struggle in this class.

- Stay current, do not fall behind. We cover a lot of new material every day; day in and day out until the very end of the course. Just wait until we go through the lower extremity in 3 days on top of what we have already done for upper extremity.

- Last note, for most of you, this is really your only opportunity to explore by full dissection how we are really put together. For most of your collective careers you will be driven to do minimally invasive surgery, this means you do not get to slice and dice from stem to stern to see the surgical field. So you really have to know where stuff is from the start.

- It really is a very rare privilege to dissect the human body, enjoy this class it goes all too quickly.
UPPER EXTREMITY

The upper extremity is divided into two major subdivisions, the Arm and the Forearm; each subdivision is further subdivided into an Anterior and a Posterior compartment. The Arm and the Forearm are separated by the Cubital Fossa (elbow).

Osteology of the Arm
Moores 3rd ed. p402-408 & Grant's Atlas 12th ed. 6.2

A. The Humerus:
1. Features of the Superior End
   a. The head articulates with the glenoid fossa.
   b. The greater tubercle is lateral and forms the insertion for (from superior to inferior) Supraspinatus, Infraspinatus and Teres Minor muscles.
   c. The lesser tubercle is directed anterior and represents the insertion of the subscapularis muscle.
   d. The intertubercular (bicipital) groove lies between the greater and lesser tubercles. It contains the tendon of the long head of the biceps muscle. Inflammation of the tendon/sheath result in anterior shoulder pain known as Bicipital Tendinitis. See Moore 3rd ed p.440 for clinical considerations.
   e. The anatomical neck lies between the tubercles and head of the humerus; the surgical neck is located inferior to the tubercles where the axillary nerve and posterior humeral circumflex vessels wrap around the humerus. These structures are at risk with a fracture in this site. Bates, 8th ed.: p.527.
2. Features of the Middle Third.

On the posterior surface and in the middle third of the humerus, the spiral groove marks the course of the radial nerve and profunda brachii vessels from anteromedial to posterolateral in the arm. The nerve and vessels are intimately associated with the surface of the bone in this site and are at risk in the event of a midshaft fracture. The sharp edges of the broken bone may compromise the radial nerve and/or profunda brachii and extreme care must be taken in this type of break to avoid further complications to patient and physician (i.e. malpractice, see Moore 3rd ed. p407 for discussion).

3. Features of the Inferior End of Humerus

Moores 3rd ed. p406, 407 Fig 6.5
Grant's Atlas 12th ed. 6.49

a. The trochlea is the spool-shaped process on the medial side of the distal end of the humerus that articulates with the trochlear notch of the ulna to form the hinge joint of the elbow.
b. The capitulum, or "little head" is the rounded end of distal humerus located on the lateral side. It articulates with the head of the radius.
c. The coronoid fossa is an anterior depression on the surface of the humerus superior to the trochlea. It is occupied by the coronoid process in full elbow flexion.
d. The olecranon fossa is a depression on the posterior surface of the humerus which is occupied by the olecranon process during full extension of the elbow.
e. The medial epicondyle is the roughened area on the medial side of the humerus superior to the trochlea. This structure represents the common origin for the superficial and middle groups of flexor muscles of the forearm.
f. The lateral epicondyle is the roughened area on the lateral side of the humerus superior to the capitulum. It forms the common origin for the superficial group of extensor muscles of the forearm.

Osteology of the Forearm
Moores 3rd ed. p406-408
Grant's Atlas 12th ed.: 6.2, 6.49, 6.5

1. The ulna forms a hinge articulation at the elbow and represents the principal weight-bearing component of the forearm at this site. It narrows distally and takes little part in the wrist joint. The head and neck of the ulna are located at the distal end. The styloid process is palpable on the medial side of the wrist. Moores 3rd ed. p402-404, figs 6.1-6.2.

2. The radius mediates supination and pronation. It represents the major weight-bearing bone at the wrist. At the proximal end, the head of the radius articulates with the capitulum of the humerus. At the distal end the radius articulates with the proximal row of carpal (wrist) bones.

3. In transmitting forces from the hand up the forearm stresses are conducted across the interosseous membrane (a very tough sheet of connective tissue composed primarily of collagen) from the radius to the ulna. Consistent with this function, the fibers of the interosseus membrane are directed down from radius to ulna. The anterior and posterior neurovascular bundles are named according to their relationships to this membrane.
B. Elbow Joint (Grants Atlas 12th ed 6.50, 6.51, 6.52)

1. At the posterior aspect of the elbow the olecranon process is palpable. The olecranon bursa lies between the bone and the skin and may become inflamed, presenting as olecranon bursitis (see Moore 3rd ed, p480 for clinical implications). The medial epicondyle and lateral epicondyle also are readily palpable. Just below and behind the lateral epicondyle there is a fossa where the radial head can be palpated.

2. The humeroulnar articulation is the major weight-bearing portion of the elbow. The deep trochlear notch of the ulna and strong collateral ligaments restrict the elbow joint to a hinge type of action and largely permits only flexion and extension (Moore 3rd p479, p478 Fig 6.33 and p481 Fig 6.36).

3. The radial head is simultaneously articulated proximal to the capitulum of the humerus and to the medial aspect of the ulna. The position of the radial head is stabilized and held in place by an encircling annular ligament. The superior radioulnar joint acts with the inferior radioulnar joint and permits pronation and supination of the forearm. In this motion the distal radius rotates around the distal ulna in a longitudinal axis that passes through the radial head proximally and the ulna distally (Moore 3rd ed. p478 Fig 6.33 and p481 Fig 6.36).

4. The elbow joint is innervated by all the nerves that cross it.

Anterior Compartment Muscles:

All muscles of the anterior (flexor) compartment are innervated by the musculocutaneous nerve (C5 - 7). Spend adequate (lots of) time learning innervation patterns, this is at least half the battle in learning the anatomy of this region and it is critical to diagnosing injuries to the upper extremity (and passing the tests). Moorres 3rd ed. p436-439
A. Biceps brachii (C5, C6): The most superficial muscles of the anterior compartment of the arm. Moores 3rd ed. p 436 Fig 6.16, Grant's Atlas 12th ed.: 6.33, 6.34

(1) Origins
   (a) Long head from the supraglenoid tubercle of the scapula
   (b) Short head from the coracoid process
(2) Insertion on the radial tuberosity and bicipital aponeurosis
(3) Actions
   (a) Flex the elbow
   (b) Powerful supinator of the forearm, especially of the flexed pronated forearm. This is because of its insertion on the tuberosity of the radius
   (c) The biceps cross the shoulder joint, as a result, this muscle flexes, adducts and medially rotates the shoulder

B. Brachialis (C5, C6): Deep to biceps on the distal humerus. Moores 3rd ed. p436, Fig 6.16; Grant's Atlas; 12th ed.: 6.33, 6.34

(1). Origin, arises from the lower 2/3 of the shaft of the humerus
(2). Inserts into ulnar tuberosity
(3). Action: powerful, very powerful, elbow flexor

C. Coracobrachialis (C6, C7) : Deep to biceps on the proximal humerus. Moores 3rd ed. p436, Fig 6.16: Grant's Atlas 12th ed.: 6.33

(1).Origin, arises from coracoid process of the scapula.
(2). Inserts into medial border of the humerus at midshaft
(3).Action: adduction and flexion at the shoulder.

Superficial and Deep Dissection of Anterior Compartment, Upper Extremity
Posterior Compartment Muscles

Muscles of the Posterior (extensor) compartment muscles are all innervated by the radial nerve.

Grant's Atlas 12th ed.: 6.34, 6.37, 6.38

D. Triceps (C6, C7, C8), Moores 3rd ed. p438, Fig 6.17

(1). Origins (three heads)
   (a). Long head: infraglenoid tubercle
   (b). Lateral head: posterior on the shaft of the humerus and lateral to the spiral groove
   (c). Medial head, posterior on the shaft of the humerus and below the spiral groove

(2). Common insertion on the olecranon process of ulna

(3). Actions
   (a). The long head can extend and adduct the shoulder.
   (b). It is THE EXTENSOR at the elbow.

Note: When testing the function of the triceps it is desirable to eliminate gravity by checking extension with the arm abducted to the horizontal plane.

E. Anconeus (don’t look for this muscle) is a small muscle arising from lateral epicondyle of humerus, inserting into lateral side of olecranon and ulna. Like the effective extensor of the elbow, it is innervated by the radial nerve.

Neurovascular relationships

Moores 3rd ed. p439-441

1. The brachial artery and median nerve leave the axilla and enter the medial intermuscular septum of the arm. The brachial pulse can be palpated midway along the arm. The artery and nerve pass along the front of humerus and enter the antecubital fossa. A supracondylar fracture of the humerus or elbow dislocation may compromise these structures in this space. Blood pressure is usually measured in the brachial artery because: 1) its location at the vertical level of the heart minimizes confounding effects of gravity; and 2) the artery lies deep in the arm where the blood flow can be halted by compressing it against the underlying muscle and bone (Moores 3rd ed. pp 439 blue box for clinical discussion).

2. The ulnar nerve diverges from the brachial artery at midarm to pass behind the medial epicondyle where it enters the forearm between the heads of the flexor carpi ulnaris.
3. The **radial nerve** and **profunda brachii (deep brachial)** branches of the brachial vessels diverge from the brachial artery high in the arm and spiral around to the posterior aspect humerus along the midshaft between the medial and lateral heads of the triceps muscle. Here they lie in the spiral groove and may be damaged in a humeral midshaft fracture. Just below the insertion of the deltoid the radial nerve reaches the lateral intermuscular septum and then passes between the **brachioradialis** and **brachialis** muscles to enter the forearm.

4. The **musculocutaneous** nerve pierces the **coracobrachialis** muscle to run through the anterior compartment of the arm between the **biceps** and **brachialis**. It emerges laterally as the **lateral antebrachial cutaneous nerve**.

5. **Collateral circulation** at the elbow (Grant’s Atlas 12th ed.: table 6.9; Moores 3rd ed. p439-441, 454 Fig 6.24, p455 Fig 6.10). **Know** the concept that redundant arcades of vessels located medial, lateral and posterior to the elbow joint conduct blood from the brachial artery to the radial and ulnar arteries. When you can draw a map of these structures from memory you know them well enough.

**Cubital (Antecubital) Fossa**

Grant’s Atlas 12th ed.: 6.45.

**Boundaries** (of a triangle)
1. **Pronator teres** medially
2. **Brachioradialis** laterally
3. **Line connecting medial and lateral epicondyles** of humerus

**Contents**
From lateral to medial mnemonic= **BAN**
Moores 3rd ed. p442 Fig 6.19 & p443 SA6.3.

1. Biceps tendon
2. Brachial Artery
3. Median Nerve
Clinical consideration:

1. The **venous arch** formed in the superficial fascia on the dorsum of the hand is drained up the extremity by the **cephalic vein** (on the radial side of the forearm) and the **basilic vein** (on the ulnar side). The **cephalic vein** continues through the arm in the superficial fascia, to drain into the axillary vein. The **basilic vein** crosses the elbow, then dives deeper, becoming the **axillary vein** as it crosses the tendon of the teres major. Brachial veins (those accompanying the brachial artery) also contribute to the formation of the axillary vein. Moores 3rd ed. p439-440.

2. A venous channel, called the **Median Cubital Vein** that connects the cephalic and basilic veins in the cubital fossa is often used for venipuncture. An extension of the biceps tendon, the **bicipital aponeurosis**, lies deep to the veins and normally protects the underlying brachial artery and median nerve. Grants 12th ed 6.46

3. On occasion, the brachial artery will divide in the arm, resulting in an anomalous **superficial brachial, superficial radial** or **superficial ulnar** which may pass superficial to the flexor muscles in the cubital fossa, where it may be mistaken for the median cubital vein. Any substance injected into the anomalous artery is delivered in high concentrations to the forearm and hand instead of being diluted in passage through the venous return to the heart.