1. You’re working in the ER Sunday morning when one of the anatomy teaching staff shows up. We won’t name names, but she’s obviously hung over. From what you can piece together from her story and the headlines in the Providence Journal, she got into a tussle with a trio of bouncers at a local club. Although she managed to put two of them down, the third one (the big one) grabbed her proximal arm, right at the axilla, and threw her out a window. You’re concerned that her brachial plexus may have been damaged when the big bouncer grabbed her, but she’s generally groggy and sore, so you decide you need to perform some specific tests. **Describe one motor and one sensory test you could perform to evaluate possible damage to the following regions of the brachial plexus. For example: motor test – “ask patient to…”, sensory test – “check for sensation on skin over/above/in the region of…”** (12 pts)

   **A. medial cord**
   - motor test =-flex distal interphalangeal joint of digits 4 & 5 to test ulnar nerve function, which innervates the medial half of the flexor digitorum profundus (FDP) and is a branch of the medial cord
   - sensory test = check for sensation on the palmar side of the 5th digit to test for ulnar nerve function, which innervates the sensory fibers of this area and is a branch of the medial cord

   **B. median nerve**
   - motor test = ask patient to flex, extend, and abduct her thumb because the thenar eminence is innervated by the median nerve
   - sensory test = check for sensation on the tips of digits 2 and 3 and medial half of 4, which is innervated by the median nerve

   **C. upper spinal roots (= C5/C6 = superior trunk)**
   - motor test = ask the patient to medicus, med a small way extend the arm at the glenohumeral joint because loss of deltoid function should make this difficult if the axillary nerve is damaged, which ultimately comes from C5/C6
   - sensory test = check for sensation on the skin over the deltoid because it is innervated by the axillary nerve which gets input from C5+C6

2. **Pulmonary artery catheterization** is used for a number of diagnostic measurements, in particular to measure “mixed venous” blood gases.

   A. Based on your knowledge of anatomy, describe how you would catheterize this artery, beginning at the right subclavian vein. List, in correct order, each structure (vessel, valve, chamber, etc.) through which the tip of the catheter passes. (8 pts)

   - right subclavian vein
   - brachiocephalic vein
   - SVC
   - right atrium
   - tricuspid valve
   - right ventricle

   **B. What do you think the “mixed” refers to in this description?** (2 pts)

   "Mixed" may refer to the fact that the blood in the pulmonary artery contains venous blood that has come from the inferior vena cava, superior vena cava, and cardiac sinus, which all dump into the right atrium and mix before entering the pulmonary artery.
3. The following paragraph contains eight mistakes. Circle and correct each mistake. (8 pts).

The nerve fibers making up the brachial plexus arise from spinal levels C5-T1. The roots of the plexus are actually the ventral rami of the spinal nerves and contain sensory, somatic motor, and sympathetic nerve fibers. The posterior cord is formed from the posterior divisions of the superior, middle and inferior trunks. The anterior divisions of the superior and middle trunks join to form the lateral cord, a branch of which joins a branch from the posterior cord to form the median nerve. The musculocutaneous nerve is a branch from the lateral cord containing nerve fibers from C5 and can be found piercing the brachialis muscle. The radial nerve is a branch from the posterior cord and is responsible for innervation to the dorsum of the hand.

4. “Tennis elbow” is known clinically as lateral epicondylitis and “golf elbow” is medial epicondylitis. For each of these conditions, name two movements that would be most affected. (8 pts)

A. Tennis elbow (lateral epicondylitis)

- Extension of the wrist
- Extension of the fingers

B. Golf elbow (medial epicondylitis)

- Flexion of the wrist
- Flexion of the fingers
5. The pictures below show the progression from rock to paper to scissors. Name 5 muscles that will be used for each transition. (10 points)

Rock to paper:
1. extensor digitorum
2. extensor indicis
3. extensor digiti minimi
4. extensor pollicis longus
5. extensor pollicis brevis

Paper to scissors:
1. flexor digitorum superficialis
2. flexor digitorum profundus
3. flexor pollicis longus
4. flexor pollicis brevis
5. opponens pollicis

6. Explain how a muscle can be injured during a motion that is the opposite of the action of that muscle (e.g. triceps can be injured during elbow flexion). (4 pts)

Muscles can forcefully lengthen or remain isometric in order to oppose the action of a joint. Antagonistic muscles, for example, the triceps may undergo injurious forceful lengthening while the biceps, brachialis, coracobrachialis, and brachialis are contracting. In general, it doesn't happen when the exact antagonist muscles contract but when opposing an external force.
7. During the motor test shown in the picture above, the physician places the patient's upper limb behind his back.

A. The patient is unable to rotate his forearm/hand away from his back. Which rotator cuff muscle is most likely injured? (2pts)

the subscapularis is most likely injured because it can mediate medial rotation of the shoulder to bring the forearm/hand away from the back.

B. Injury to this muscle would lead to vulnerability for anterior/posterior/superior/inferior (circle one) dislocation (2 pts)

C. The movement of the forearm and hand away from the body described above above involves what kind of movement at which joint? (4 pts)

medial rotation at the glenohumeral joint
8. In the cross-section to the right:
   A. Circle the region of the gray matter that contains cell bodies of somatic motor neurons. (2 points)
   \[ \Rightarrow \text{ventral horn} \]
   B. Clearly label the spinal nerve. (2 points)
   C. Place an “X” over the primary nerve ramus that supplies the muscles of the back (the epaxial muscles). (2 points)
   \[ \Rightarrow \text{dorsal ramus} \]

9. In the T5 cross-section to the right:
   A. Circle the region of the gray matter that contains cell bodies of autonomic motor neurons. (2 points)
   \[ \Rightarrow \text{lateral horn} \]
   B. Starting from the circled region, and using the primary ventral ramus as a termination point, draw a line that shows the path to a sweat gland that overlies the 5\textsuperscript{th} rib. (4 points)
   \[ \Rightarrow \text{at T5 \rightarrow pre-ganglionic cell} \]
   \[ \Rightarrow \text{terminates on a post-ganglionic cell at the same level} \]

Points missed: 0
10. Fill in the blanks on this fate map of the three primary germ layers (17 points)

ectoderm → surface ectoderm → epithelium (i.e., epidermis) → hair

neural tube → brain → spinal cord

neural crest → tooth enamel → head structures → dorsal root ganglia

epithelium is a type of ectodermal tissue (example: epidermis)

mesoderm → axial → notochord → part of intervertebral disks

paraxial → somites → sclerotome → vertebrae

dermatome → dermis

myotome → limb muscles

epimere → hypomere

intermediate → urogenital system

lateral plate → somatic lateral plate → c.t. and vessels of body wall/limbs

parietal pleura/peritoneum

splanchnic lateral plate → smooth muscle

endoderm → lining of the GI tract and respiratory tract

c.t. and vessels of the inner tube → visceral pleura/peritoneum

Great work!
11. **Multiple choice questions** (2 points each)

A 15 year-old boy gets a superficial laceration (cut) of the palm at the base of his thumb. The wound is closed with sutures (stitches) at the ER, but the following day the boy complains of diminished hand function. Clearly, one of the sutures damaged the **recurrent branch of the median nerve**. Which movement is most affected?

A) Abduction of fingers  
B) Adduction of fingers  
C) Flexion of joints of the second finger  
D) Flexion of thumb joints  
E) Opposition

A 2 year-old girl is brought to the ER complaining of elbow pain. The father says that her distress came on suddenly when he helped lift her from the stroller with her arm extended. Which is the most likely cause of the pain?

A) Compression of the median nerve within the supinators  
B) Separation of the radius from the trochlea of the humerus  
C) Separation of the radius from the capitulum of the humerus and the ulna  
D) Separation of the ulna from the trochlea of the humerus  
E) Stretching of the radial nerve as it passes behind the medial epicondyle.

A bicycle rider complains of weak abduction and adduction of her fingers but has no difficulty flexing them. She has decreased sensation over the palmar surface of fingers 4 and 5. What nerve is compressed?

A) Median nerve in carpal tunnel  
B) Median nerve at pronator teres  
C) Radial nerve at supinator  
D) Ulnar nerve at medial epicondyle  
E) Ulnar nerve at pisiform bone

Myocardial infarction (heart attack) caused by occlusion (blockage) of the circumflex branch of the left coronary artery is most likely to occur in which of the following locations?

A) Apex  
B) Left atrium and left ventricle  
C) Right and left ventricles  
D) Right atrium and right ventricle  
E) Right ventricle and interventricular septum
1. R somatic motor fibers (phrenic)  
   B endoderm (oesophageus)  

2. Razygous vein  
   B superior vena cava (SVC)  

3. R deltoid  
   B biceps brachii  

4. R tendon of the flexor digitorum profundus  
   B posterior cord  

5. R flexor of the elbow  
   B radial nerve  

6. R left ventricle  
   B great cardiac vein  

7. R deep palmar arch  
   B recurrent median nerve (minor)  

8. R right main bronchus  
   B endoderm (airways)  

9. R median nerve  
   B pisiform  

10. R intercostal muscles (internal)  
    B intercostal nerve  

11. R caracoid  
    B throracovromial artery  

12. R trapezium  
    B radius  

13. R teres minor  
    B lateral rotation of the humerus  

14. R musculocutaneous nerve  
    B C5, C6, C7  

15. R ligamentum arteriosum  
    B larynx  

16. R deltoid  
    B lateral thoracic artery  

17. R abductor pollicis longus  
    B adduction of the thumb  

18. R pronation of the forearm  
    B radial nerve  

19. R Supinator  
    B biceps brachii  

20. R pleural cavity  
    B intercostal artery, vein, & nerve  

21. R acromioclavicular joint  
    B tendon of the biceps brachii (longhead)  

22. R no (unless patient has situs inversus)  
    B gastric bubble on right, not left, @ the  
    apex of the heart is on the right, not  
    left as is usual  

23. R elevation of scapula  
    B suprascapular nerve  

24. R 4th digit minimi  
    B C8, T1  

25. R pronation of forearm  
    B superficial palmar arch