1. **Number** the structures below to place them in **the correct sequence** along the path of sensory inflow from a bee sting on the forearm. The first and last structures (#1 and #10) are numbered for you (4 pts)

1. pain receptor in skin over brachioradialis muscle
2. dorsal root
3. lateral cord of brachial plexus
4. anterior division of superior trunk
5. musculocutaneous nerve
6. superior trunk of brachial plexus
7. ventral ramus of C6
8. C6 spinal nerve
9. lateral cutaneous nerve of the forearm
10. spinal cord

2. **Number** the structures below to place them in **the correct sequence** along the path of sympathetic motor outflow to a sweat gland. The first and last structures (#1 and #10) are numbered for you (4 pts)

1. lateral horn of gray matter at level T4
2. lateral cutaneous branch
3. spinal nerve
4. white ramus communicans
5. synapse with postganglionic neuron
6. gray ramus communicans
7. ventral root
8. sympathetic chain ganglion
9. ventral ramus = intercostal nerve
10. sweat gland in skin around nipple
3. Describe two anatomical differences between the sympathetic and parasympathetic nervous systems. (4 pts)

- The Sympathetic Nervous System is confined to Spinal Nerves T1-12, whereas the Parasympathetic Nervous System consists of 4 cranial nerves and 3 Sacral Nerves (S2-S4). Giving no physical overlap between the two (there is sensory overlap, however). Secondly, the Parasympathetic N.S. has very long preganglionic axons that synapse very close to (generally in the walls of) their target organs, while the Sympathetic N.S. has short preganglionic axons that synapse in the Sympathetic chain ganglia, generally far from their targets.

4. Below is a diagram of half an embryo early in the process of neurulation and formation of the first divisions of the mesoderm. Fill in the blank labels to identify the indicated tissues. (5 pts)

- Paraxial Mesoderm
- Surface Ectoderm
- Notochord
- Intermediate Mesoderm
- Somatic Lateral Plate Mesoderm
- Splanchnic Lateral Plate Mesoderm

5. Fill in the blanks. Be as specific as possible in naming the subdivisions of the germ layers. (5 pts)

The brain develops from **neurectoderm**, the epithelial linings of the lungs develop from **endoderm**, the parietal pleura develop from **somatic l.m.** smooth muscle in the wall of the intestines develops from **splanchnic l.m.**, and the biceps muscle fibers develop from **hypaxial paraxial mesoderm**.
6. The drawing below represents the heart of a neonate (recently born baby). The lungs inflated normally, so normal adult circulation would have been established except for several severe congenital malformations.

A. Structure X **develops from** which germ layer or germ layers? Be as specific as possible in naming the subdivision of the germ layer(s). (4 pts)

- Splanchic lateral plate mesoderm
- or Cardiac tube end mesoderm

B. One of the major malformations shown here is patent foramen ovale, due to incomplete formation of the atrial septum. **Describe** two other congenital cardiac malformations shown above, and in each case **explain** which normal part of heart development failed. (6 pts)

- There is an **incomplete closure of the interventricular septum**, due to a defect in the stage of heart development when it is divided into 4 chambers. This would allow for the **mixing of oxygenated + deoxygenated blood**.

- Moreover, the ductus Arteriosus is still present (has not become ligamentum arteriosum), which would also allow for the **mixing of oxygenated and deoxygenated Blood**.

- **Transposition of Great vessels** blk truncusoanal septum failed to Spiral

Points missed: 0
7. The following is an incomplete description of the structure of the brachial plexus. **Complete the description by filling in the blanks.** The first blank is filled in for you. (11 pts)

The ventral rami of C5 and C6 together form the **superior trunk** of the brachial plexus. The ventral ramus of **C7** forms the middle trunk, and the ventral rami of **C8 and T1** form the inferior trunk. The **Anterior divisions of the Middle and Superior trunk** form(s) the lateral cord, and the **Anterior division of the Inferior trunk** form(s) the medial cord. The lateral cord contributes to two terminal branches, the **Musculocutaneous Nerve** and the **Median Nerve**. The medial cord, likewise, contributes to two terminal branches, the **Median Nerve** and the **Ulnar Nerve**. The posterior cord is formed from the **Posterior Divisions** of the three trunks. Its terminal branches are the **Axillary Nerve** and **Radial Nerve**.

8. Starting from the anatomical position, pick up your pen. **List four muscles that have an attachment in the hand** that you used to arrive at the position shown above. (4 pts)

- Flexor Digitorum Superficialis
- Flexor Digitorum Profundus
- Opponens Pollicis
- Flexor Pollicis Brevis (and longus)
9. Coarctation of the aorta is a congenital narrowing of the aorta adjacent to the site of attachment of the ligamentum arteriosum. The narrowing occurs when, after birth, as the ductus arteriosus contracts, the ductal muscle in the aortic wall also contracts, and the aortic lumen becomes narrowed as shown in the drawing below.

A. Given the site of coarctation shown in the drawing, circle the arteries in the list below that would experience diminished flow. (5 pts)

- Right carotid artery
- Left ulnar artery
- Right dorsalis pedis artery in the foot
- Left femoral artery (lower limb)
- Anterior interventricular artery

B. Patients with this condition present with enlargement of the subclavian, internal thoracic (= internal mammary), and intercostal arteries. Explain why these specific vessels are enlarged. (2 points)

This condition would cause a backup, leading to increased blood pressure to accommodate for decreased blood flow. This rise in BP would affect these arteries because they are all "upstream" (closer to the heart), resulting in increased flow.

10. Though most people have 12 pairs of ribs, it's estimated that in 1% of the population supernumerary (extra) ribs are present. Cervical ribs are a common type of supernumerary ribs, they articulate with the C7 vertebrae. Provide a compelling anatomical explanation as to why the presence of a cervical rib could lead to the following symptoms:

A. Numbness and tingling of the skin along the ulnar border of the forearm. (3 pts)

The Cervical Rib may be compressing the Medial antebrachial cutaneous nerve directly, the inferior trunk of the Brachial plexus, or the C8 ventral Ramus which leaves though the vertebral column just below C7, where this rib would articulate. All of the above could lead to the conditions described.

B. Ischemic muscle pain in the upper limb. Ischemia is a condition of poor oxygenation of a tissue, caused by reduced blood flow. (3 pts)

The Rib may be compressing the Subclavian/axillary artery, which supplies blood to the upper limb. (Turns into Brachial Artery).
In addition, the Subclavian - Internal thoracic - Intercostal Artery System can serve as an anastomosis for Blood to get to the lower extremities.

This is because the Internal thoracic artery Branches off of the Subclavian, and the intercostal arteries Branch off of Both the Internal thoracic Artery and descending Aorta.

- The Size (flow) of these 3 arteries can compensate for the lack of flow in the thoracic (descending) aorta.
11. On the drawing below, sketch in and label: (4 points)

A. the outline of the lungs.
B. the outline of the heart.
C. the superior profile of the diaphragm.
D. the left 5th intercostal space.

12. One of the surgical treatments for loss of function of a muscle or group of muscles involved in hand movement is tendon transfer surgery. In this procedure, the insertion of one muscle is relocated to a new site of attachment, to perform a new function. The paragraph below describes two of the more common types of tendon transfer surgery. Within the paragraph are 5 mistakes. Circle the mistakes, and substitute the correct word. (10 pts)

The extensor pollicis longus, one of the intrinsic muscles of the hand, is sometimes injured coincident with fracture of the wrist. A good candidate for tendon transfer is the extensor indicis muscle, because extension of digit II can also be accomplished by the extensor digitorum muscle. During surgery, the ligament is detached from its insertion, and attached to the middle phalanx of the thumb. After surgery, the transferred muscle should be strengthened by opposition of the thumb against resistance. If the radial nerve is damaged, rather than just the extensor pollicis longus, then an alternative surgery is required. In this case, a tendon from the anterior compartment of the forearm could be used, because digital flexors are innervated primarily by the ulnar nerve.
13. Below are listed several possible next steps in the path of a red blood cell as it passes through the circulatory system. For each of the possible paths, indicate whether it occurs in the normal adult circulatory system, the normal fetal circulatory system, or in neither system. Paths may be appropriate for both the fetal and adult circulatory systems. Each case should represent a “next step”, with no missing intervening vessels or chambers. Part “D” is done for you. (7 pts)

A. inferior vena cava → right atrium  
B. right atrium → left atrium  
C. right atrium → superior vena cava  
D. right atrium → right ventricle  
E. right ventricle → pulmonary trunk  
F. ductus arteriosus → aorta  
G. left ventricle → aorta  
H. aorta → right common carotid artery

<table>
<thead>
<tr>
<th></th>
<th>Adult</th>
<th>Fetal</th>
<th>Neither</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✗</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>D</td>
<td>✗</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>✗</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>H</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

For 4 of the paths above, blood must pass through a named valve or foramen. Below, give the letter of the path and the name of the valve or foramen. (8 pts)

<table>
<thead>
<tr>
<th>Letter</th>
<th>Name of valve or foramen</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Foramen Oval</td>
</tr>
<tr>
<td>D</td>
<td>Tricuspid Valve</td>
</tr>
<tr>
<td>E</td>
<td>Pulmonary Semilunar Valve</td>
</tr>
<tr>
<td>G</td>
<td>Aortic Semilunar Valve</td>
</tr>
</tbody>
</table>

14. A chest tube has been inserted through the 5th intercostal space at the mid-axillary line to drain the pleural cavity. Name the major tissue planes and muscles that have been traversed, from superficial to deep. (5 pts)

Skin → Serratus Anterior → External Intercostal Muscles → Internal Intercostal Muscles

(Stop!) Pleura

Points missed: 1
15. For the following questions, choose the single best answer and circle it. (2 pts each)

Tumors may spread from one breast to the other across the midline. Which of the following lymph nodes are most likely involved in this metastasis:

a. humeral lymph nodes  

b. parasternal lymph nodes  

c. posterior axillary lymph nodes  

d. parabronchial lymph nodes  

e. mediastinal lymph nodes  

A 20-year-old man is stabbed just lateral to the sternum, through the left fifth intercostal space. The knife most likely penetrated the:

[Answer: Correct Ans. = D]

A football player is examined by the team physician following a shoulder injury during a game. Preliminary x-ray films show an inferior dislocation of the humerus. On further examination, there is weakness in lateral rotation and abduction of the arm. The nerve most likely affected is the:

[Answer: Deltoid, Supraspinatus, Subscapularis, Axillary N.]

Take home point: don’t try to answer the questions like I did on these last 2.