Contents

Preface ......................................................... v

Exercises

Development of the Vertebrate Body Plan ......................... 7

Structural Patterns ........................................... 11

Skeletal Muscles ............................................. 21

Vertebral Anatomy and the Meningeal System ..................... 33

Overview of the Central Nervous System ......................... 39

Spinal Nerve Anatomy ...................................... 41

Dorsal Rami .................................................. 43

Autonomic Nerves .......................................... 45

Mediastinum .................................................. 55

Cervical Plexus .............................................. 57

Brachial Plexus ............................................. 61

Intercostal Nerves .......................................... 67

Lumbosacral Plexus Anatomy ................................ 69
Preface

This book is a workbook to accompany the Advanced Human Anatomy Lecture Manual and your course of study in both lecture and the laboratory. If used properly it will be a powerful learning tool to guide your study in the advanced anatomy course.

I strongly suggest that you use this book daily. Each of the exercise chapters has a variety of questions intended to make you think about and review your knowledge of the material covered in the lecture portion of the course. You should complete these exercises each day after studying the related material from the lectures. This will help you to reinforce your knowledge and evaluate your learning progress. Students who diligently utilize this manual on a daily basis will be more likely to succeed in the course.

The Advanced Human Anatomy Course provides many hours each week to visit the laboratory and study the cadaver dissections. I strongly encourage you to take advantage of this wonderful opportunity. Students who excel in the course make the effort to visit the open lab times as often as possible.

A critical foundation for this course is a strong knowledge of skull anatomy. I
cannot over emphasize the importance of having a strong working knowledge of the skull. Use this workbook, in combination with visiting the lab, to study the skull and learn it well. It will pay big dividends for you in this course.

Work hard, keep current, use the materials provided for your study, take advantage of the many hours that are available for you to study the cadavers in the lab and talk to the teaching assistants, and there should be no reason not to succeed in the course.

Mark Nielsen
University of Utah
**Key Stages in the First Week of Development**

In the column below, write a bulleted outline that describes the developmental events that accompany the illustrations on the right of the page. You should clearly caption each illustration and color-code the illustrations with the key below.

**Color**
- [ ] Blastomeres
- [ ] Trophoblast
- [ ] Embryoblast
- [ ] Epiblast
- [ ] Hypoblast
- [ ] Amnion
- [ ] Yolk sac
**Gastrulation**

Describe the stages in the important embryonic event called gastrulation. Your description should be accompanied by simple labeled illustrations. Clearly define all the important embryonic structures that arise as a result of gastrulation.

**Neurulation**

Starting with a simple straight horizontal line, draw a series of five successive illustrations that depict the embryonic process called neurulation. Clearly label all aspects of your drawing.

How do the neural tube and neural crest differ cranially and post-cranially?
Describe the developmental potential of the ectodermal placodal ring.

**Modifying the Mesoderm**

On the illustrations to the right, color-code the structures in the legend below. For each structure describe the structures that arise from it during development.

**Color**

- Notochordal process
- Prechordal mesoderm
- Cardiogenic mesoderm
- Paraxial mesoderm - somites
- Paraxial mesoderm - unsegmented head mesoderm
- Intermediate mesoderm
- Somatic lateral plate mesoderm
- Splanchnic lateral plate mesoderm
**Embryonic Folding**

On each of the illustrations below, color all ectodermal anatomy blue, mesodermal anatomy red, and endodermal anatomy yellow.

![Embryonic Folding Diagram](image)

**The Basic Vertebrate Body Plan**

For each of the sections of the embryo indicated below, describe the coelomic relationships of the gut at that section and the size and position of the neural tube and neural crest.

![The Basic Vertebrate Body Plan Diagram](image)
**EXERCISES - STRUCTURAL PATTERNS**

**Developmental Features of the Embryonic Trunk**

The upper illustration below depicts a section of a developing vertebrate trunk. Using the legend below, color-code each of the structures. In the lower illustration, color each structure the same color as the structure it develops from in the upper illustration and clearly label all structures in the lower illustration.

**Color**

- [ ] Dematome
- [ ] Sclerotome
- [ ] Epimere of myotome
- [ ] Hypomere of myotome
- [ ] Gut tube
- [ ] Neural tube
- [ ] Neural crest
- [ ] Dorsal blood vessels
**Limb Muscle Patterns**

The illustrations on this page represent sections through the upper limb and body wall. Do the following for all three illustrations: color all the body wall muscles red and color all the limb muscles blue. In the upper illustration, label all the muscle groups depicted in the illustration. In the middle illustration clearly indicate which muscles are annexed by the limb from the body wall and which muscles from the limb grow back onto the body wall. In the lower illustration label all the muscles by their name.
Clearly explain the developmental differences observed in the lower limb compared to the upper limb. How does this influence the terminology associated with muscle compartments and muscle innervation?

Costovertebral Patterns

Clearly explain how the development of the sclerotome establishes the serial homologous pattern that is observed in the bony structure of the trunk. What relationship does this development have to skull anatomy?

Fascial Patterns in the Body Wall

In a broad sense, fascia is any enveloping connective tissue within the body. Using simple labeled drawings, clearly describe how the “fascial tissues” of the body arise during development.
If the rectangle below represents a section through the skeletal muscle wall of the trunk, clearly **draw** and **label** the associated pattern of fascia and other tissues on both the internal and external aspect of the skeletal muscle section using a series of corresponding rectangles. Use coordinated colors to clearly depict the mirror image relationship that exists in this pattern. Your answer should list both the names of the associated layers and the tissues of the named layers.

**Skeletal Musde**

On the three Netter illustrations, below and on the facing page, use the colors you used in the question above and clearly color code the body wall layers on each of the illustrations. On each of the illustrations, label by name all the complex terms anatomists use to name the fascia and layers.
On the illustration below, clearly draw and label the body wall and limb fasciae in proper relationship to the muscles. Label all the muscles depicted in the illustration. Clearly describe how the body wall and limb fascia of the lower limb differ from that of the upper limb that you illustrated here.
Peripheral Nervous Patterns

On the illustrations below, clearly draw the neuronal development that accounts for the adult anatomy of the peripheral nervous system for the levels indicated below the illustrations. Color all neurons that develop from the neural tube red and all neurons that develop from the neural crest blue. With labels and leader lines, label all neurons by name (i.e., skeletal motor, preganglionic motor, etc.) and clearly label all the nerves that the neurons form (i.e., dorsal root, sympathetic splanchnic nerve, etc.).
Head/Neck Patterns

The illustration below depicts numerous key stages and anlage involved in the development of the head and neck region. Using the legend below, clearly color code all parts of this illustration. With labels and leader lines, label the named muscle migrations and the ganglia and placodes.

- Neural tube
- Occipital somites
- Lateral mesoderm
- Placodes
- Neural crest
- Cervical somites
- Ventral cranial nerves
- Somitomeres
- Prechordal mesoderm
- Dorsal cranial nerves
- Neural tube, notochord, prechoral mesoderm
- Premuscular mesoderm
- Muscle migration and development
- Motor neuron development
- Peripheral ganglia development
The illustrations below depict the migrations of the muscle anlage of the head and neck and the result of those migrations. Using a distinct color for each muscle anlage, color-code the illustrations and label both the anlage and the muscles in the illustrations.
The illustration below is a cross-section of the neck at the level of the seventh cervical vertebra. Using the colors you used to designate the muscle anlage in the previous question, clearly depict the fascia that arises during the muscle migrations on this illustration. Label all muscle evident in the illustration and the detailed names that anatomists give to each area of fascia.
**Trunk Muscles**

You learned many muscles in the first anatomy course and you have added a few more to that knowledge base in this course. With your knowledge of muscles, you should be able to fill in the table below and on the following pages. Realize that the best way to learn muscles is to see them, the learner who sees the muscles will never forget them, and further more, the person who can see a muscle will be able to describe the muscle attachments and actions and most any other detail about the muscles. The learner who memorizes words without a visual link is the person who more easily forgets. Remember, the detail is in the image. Lock down the image of the muscles and you will have all the information that you will ever need.

**Cervical Trunk Muscles**

<table>
<thead>
<tr>
<th>Muscle Group</th>
<th>For each muscle group in the left hand column, list all the muscles that arise from the group in this column. For the epaxial muscles list the muscles from superficial to deep.</th>
<th>Describe the functions of the muscle(s) in this group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypaxial ventral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral outermost muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral external muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral middle muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral internal muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial subvertebral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epaxial muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle Group</td>
<td>For each muscle group in the left hand column, list all the muscles that arise from the group in this column. For the epaxial muscles list the muscles from superficial to deep</td>
<td>Describe the functions of the muscle(s) in this group</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Hypaxial ventral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral outermost muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral external muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral middle muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral internal muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial subvertebral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epaxial muscles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Lumbar Trunk Muscles

<table>
<thead>
<tr>
<th>Muscle Group</th>
<th>For each muscle group in the left hand column, list all the muscles that arise from the group in this column. For the epaxial muscles list the muscles from superficial to deep.</th>
<th>Describe the functions of the muscle(s) in this group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypaxial ventral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral outermost muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral external muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral middle muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral internal muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial subvertebral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epaxial muscles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Pelvic Trunk Muscles

<table>
<thead>
<tr>
<th>Muscle Group</th>
<th>For each muscle group in the left hand column, list all the muscles that arise from the group in this column. For the epaxial muscles list the muscles from superficial to deep.</th>
<th>Describe the functions of the muscle(s) in this group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypaxial ventral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral outermost muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral external muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral middle muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial lateral internal muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypaxial subvertebral muscles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epaxial muscles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Limb Muscles

Testing muscle movements is an effective way to access problems with the nervous system. For this reason, it is important to know which muscles can produce the specific movements at the various joints of the limbs. For each joint movement listed below, list all the muscles that can produce that movement. It would also be an excellent exercise to list the nerves that innervate each muscle you list.

Scapular Movements
Abduction

Adduction

Upward rotation

Downward rotation

Elevation

Depression

Shoulder Joint Movements
Abduction

Adduction

Flexion

Extension

Medial rotation

Lateral rotation
**Elbow Joint Movements**
Flexion

Extension

Supination

Pronation

**Wrist Joint Movements**
Flexion

Extension

Ulnar deviation or adduction

Radial deviation or abduction
**Finger/Thumb Movements**

Extend all joints

Extend IP joints

Flex all joints

Flex all but distal DIP joint

Flex MCP joint only

Abduct MCP joint

Adduct MCP joint

Abduct carpometacarpal joint

Adduct carpometacarpal joint

Oppose carpometacarpal joints
**Hip Joint Movements**
Abduction

Adduction

Flexion

Extension

Medial rotation

Lateral rotation

**Knee Joint Movements**
Flexion

Extension

**Ankle or Talocrural Joint Movements**
Plantar flexion

Dorsal flexion

**Tarsal Joint Movements**
Inversion

Eversion
Toe Joint Movements
Extend all joints

Extend IP joints

Flex all joints

Flex all but distal DIP joint

Flex MCP joint only

Abduct MCP joint

Adduct MCP joint
Head Muscles

List all the muscles of the head that arise from each of the embryonic primordia listed below. For each group of muscles list the cranial nerve that innervates them and the function of each muscle.

First Arch Muscles

Second Arch Muscles

Third Arch Muscles

Fourth Arch Muscles

First Occipital Somite or Sixth Arch Muscles

Caudal Occipital Somite Muscles

Prechordal Mesoderm Muscles

Lateral Head Mesoderm Muscles
The suboccipital muscles occupy the junction of the skull and vertebral column and are not present at any other vertebral levels. What muscles are homologous to these muscles at other vertebral levels. Clearly explain your answer and show the logic behind your reasoning.

The intertransverse muscles of the body represent a varied series of muscles that have horrendous names. Clearly explain this group of muscles using developmental logic, muscle attachments, and innervation. Propose a more logical sequence of names for these muscles.
EXERCISES - VERTEBRAL ANATOMY AND THE MENINGEAL SYSTEM

Vertebral Osteology

On each of the photos of vertebrae to the right, label the following structures on one half of the vertebra:

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>Body</td>
</tr>
<tr>
<td>☐</td>
<td>Pedicle</td>
</tr>
<tr>
<td>☐</td>
<td>Lamina</td>
</tr>
<tr>
<td>☐</td>
<td>Spinous process</td>
</tr>
<tr>
<td>☐</td>
<td>Zygaphysis or articular process</td>
</tr>
</tbody>
</table>

and the developmental origins of the vertebrae on the other half:

| ☐     | Body center                |
| ☐     | Vertebral arch center      |
| ☐     | Costal center              |

On the posterior view of the lumbar vertebra below, label the following and explain the significance and homologue of each labeled structure.

- Accessory process
- Mammillary process
- Transverse process
**Ligaments of the Vertebral Column**

On the illustrations to the right and below, label the following ligaments:

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anterior longitudinal ligament</td>
</tr>
<tr>
<td></td>
<td>Posterior longitudinal ligament</td>
</tr>
<tr>
<td></td>
<td>Ligamentum flavum</td>
</tr>
<tr>
<td></td>
<td>Interspinous ligament</td>
</tr>
<tr>
<td></td>
<td>Supraspinous ligament</td>
</tr>
</tbody>
</table>

For each ligament below list its homologue from the group above in the space to the right. One of the ligaments does not have a homologue from above.

- Anterior atlanto-occipital membrane _________________
- Posterior atlanto-occipital membrane _________________
- Tectorial membrane _________________________________
- Transverse ligament of atlas ________________________
- Superior longitudinal band _________________________
- Inferior longitudinal band _________________________
- Alar ligament ________________________________
- Apical ligament _________________________________
Using simple illustrations, clearly describe the structure of the intervertebral disc and succinctly explain how this structure excels as an intervertebral shock absorber.

---

**Cranial and Spinal Meninges**

Label the following structures on the illustration of a frontal section through the superior aspect of the head:

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periosteal dura mater</td>
</tr>
<tr>
<td></td>
<td>Menigeal dura mater</td>
</tr>
<tr>
<td></td>
<td>Dural venous sinuses</td>
</tr>
<tr>
<td></td>
<td>Arachnoid mater</td>
</tr>
<tr>
<td></td>
<td>Arachnoid trabeculae</td>
</tr>
<tr>
<td></td>
<td>Arachnoid granulations</td>
</tr>
<tr>
<td></td>
<td>Subarachnoid space</td>
</tr>
<tr>
<td></td>
<td>Pia mater</td>
</tr>
<tr>
<td></td>
<td>Brain tissue</td>
</tr>
<tr>
<td></td>
<td>Parietal bones</td>
</tr>
</tbody>
</table>

Describe the tissue of the dura mater.

Describe the tissue of the leptomeninges.
List the four dural septa and describe how these septa relate to the dura mater. What is the functional significance of these septa.

Trace cerebrospinal fluid from its production site in a lateral ventricle to its drainage into the superior sagittal dural venous sinus. Your trace should be in a columnar list in the space below.

Describe how the spinal dura differs from the cranial dura and clearly explain why this is the case.

Compare the cranial epidural space and the spinal epidural space.
What meningeal structures help to anchor and stabilize the spinal cord within the vertebral canal? Explain how they stabilize the cord.

On the illustration of the spinal cord and its associated structures, use leader lines and labels to label all the visible anatomy in the illustration.
Ventricular System and Subarachnoid Space

Describe the position and location of each ventricle of the brain and describe how the ventricles relate to the development of the nervous system.

With distinct colors, clearly label the illustrations below.

Describe how the two illustrations are related to each other.
Regions of the Brain

On each of the illustrations on this page, clearly color code the following structures:

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medullar oblongata</td>
</tr>
<tr>
<td></td>
<td>Pons</td>
</tr>
<tr>
<td></td>
<td>Cerebellum</td>
</tr>
<tr>
<td></td>
<td>Midbrain</td>
</tr>
<tr>
<td></td>
<td>Diencephalon</td>
</tr>
<tr>
<td></td>
<td>Cerebral hemipheres</td>
</tr>
</tbody>
</table>
Using labels and leader lines, completely label all the parts of the spinal cord cross-section.

Clearly and concisely explain why there are differences in the structure of the white and gray matter of the spinal cord at different spinal levels as evidenced in these illustrations.
**Basic Features of Spinal Nerves**

The following structures are visible on both of the illustrations below. For each structure, use its number to label the structure on both of the illustrations.

1. Ventral root
2. Dorsal root
3. Spinal nerve trunk
4. Ventral ramus
5. Dorsal ramus
6. Gray communicating ramus
7. White communicating ramus
8. Sympathetic trunk
9. Sympathetic splanchnic nerve
10. Parasympathetic splanchnic nerve
For each nerve in the table below, place a check in the neuron column if the neuron occurs in that nerve.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Sensory Neuron</th>
<th>Skeletal Motor Neuron</th>
<th>Preganglionic Motor Neuron</th>
<th>Postganglionic Motor Neuron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventral root</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorsal root</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal nerve trunk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventral ramus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorsal ramus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray communicating ramus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White communicating ramus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sympathetic trunk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sympathetic splanchnic nerve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parasympathetic splanchnic nerve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Clearly explain how the cauda equina develops and why a vertebral column injury in the upper lumbar region does not affect the lumbar spinal cord.

Describe the difference between a dermatome and a cutaneous field and why this is important clinically.
**Exercises - Dorsal Rami**

**Basic Features of Dorsal Rami**

Describe the basic structural pattern of the dorsal rami and sketch this structure on the photo of a vertebra below.

Precisely describe the cutaneous distribution of the dorsal rami.

Describe the muscular distribution of the dorsal rami.
Clearly describe the structural differences of the first two cervical dorsal rami as compared to the other cervical dorsal rami.

Clearly define the cutaneous distribution of each of the following:

- Cervical dorsal rami
- Thoracic dorsal rami
- Lumbar dorsal rami
- Sacral dorsal rami
- Coccygeal dorsal ramus
EXERCISES - AUTONOMIC DIVISION OF PNS

Review of Autonomic System

Clearly outline the key features of the autonomic division of the peripheral nervous system. Your outline should describe the number and types of neurons, the pathways of the neurons, the origins and distribution of the neurons, and the tissues that the neurons innervate.

Describe the visceral sensory input associated with the autonomic system.

Clearly describe the phenomenon of referred pain.
Color code each of the structures indicated below on the illustrations.

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White ramus</td>
</tr>
<tr>
<td></td>
<td>Gray ramus</td>
</tr>
<tr>
<td></td>
<td>Sympathetic trunk</td>
</tr>
<tr>
<td></td>
<td>Sympathetic splanchnic nerve</td>
</tr>
<tr>
<td></td>
<td>Sym. splanchn. nerve ganglia</td>
</tr>
<tr>
<td></td>
<td>Sympathetic trunk ganglia</td>
</tr>
<tr>
<td></td>
<td>Vagus nerve</td>
</tr>
<tr>
<td></td>
<td>Pelvic parasympathetic splan. nerves</td>
</tr>
<tr>
<td></td>
<td>Parasympathetic ganglia</td>
</tr>
</tbody>
</table>
Exercises - Autonomic Division of PNS

Nervous Traces

Diagram the following neuron traces on the illustrations of the nervous system on the pages that follow. (I have provided you with many pages so you do not have to crowd all the traces onto one page. Do two traces on each page. I also suggest that you keep one page blank so you can make copies of it to practice the traces.) When drawing the traces use the following labeling scheme: color all sensory neurons red, color all skeletal motor neurons blue, color all interneurons yellow, color all preganglionic motor neurons orange, and color all postganglionic neurons green.

1. Input from a neuron in the upper limb initiates neuronal output to a skeletal muscle in the ipsilateral upper limb.

2. Input from a neuron in the lower limb initiates neuronal output to a skeletal muscle in both the ipsilateral lower limb and the contralateral upper limb.

3. Input from a neuron in the thoracic cavity initiates sympathetic neuronal output to a blood vessel in the thoracic cavity.

4. Input from a neuron in the epaxial region of the abdominal body wall initiates sympathetic neuronal output to a blood vessel in the epaxial region of the abdominal body wall.

5. Input from a neuron in the sigmoid colon initiates parasympathetic neuronal output to the taenia coli of the sigmoid colon.

6. Input from a neuron in the sigmoid colon initiates sympathetic neuronal output to the blood vessels in the sigmoid colon.

7. Input from a neuron in the lower limb initiates sympathetic neuronal output to a blood vessel in the lower limb.

8. Input from a neuron in the stomach initiates sympathetic neuronal output to a blood vessel in the stomach.

Tips do follow when doing neuron traces:

1. Before you start, use your knowledge of spinal nerve anatomy to identify and label all the spinal levels depicted on the diagram, i.e., C1-C8, etc. (This has been done on these illustrations, but you should be able to do it on your own.)

2. Read the trace question and begin by identifying the starting point and ending point of the trace.

3. Identify whether you are doing a trace to skeletal muscle or a trace to smooth muscle.

4. If it is to smooth muscle then identify whether it is to a blood vessel (sympathetic) or to the gut tube (parasympathetic).

5. Remember the rules — sensory neurons always enter the spinal cord through the dorsal roots, motor neurons leave the spinal cord through the ventral roots, skeletal motor neurons go to the body wall via ventral (hypaxial) or dorsal (epaxial) rami, sympathetic preganglionic neurons enter the sympathetic trunk via the white communicating ramus, sympathetic postganglionic neurons leave the trunk and return to the body wall via the gray communicating ramus.

6. Always represent the location of the neuron cell bodies with a circle and draw a fork at the end of the axon to represent a synapse.
Begin and end your traces in the appropriate boxes based on nervous trace questions.

Levels C1 to C8

Levels T1 to L2

Levels L3 to S1

Levels S2 to S4

Upper Limb

Thoracic Cavity

Stomach

Sigmoid colon

Epaxial Abdominal Wall

Lower Limb

Upper Limb

Lower Limb
Begin and end your traces in the appropriate boxes based on nervous trace questions.
Begin and end your traces in the appropriate boxes based on nervous trace questions.
Begin and end your traces in the appropriate boxes based on nervous trace questions...

Levels C1 to C8
Upper Limb

Levels T1 to L2
Thoracic Cavity

Levels L3 to S1
Stomach

Levels S2 to S4
Sigmoid colon

Upper Limb
Epaxial Abdominal Wall
Lower Limb
Lower Limb
Sympathetic Nerves

On the illustration below clearly color each of the following structures in their entirety.

<table>
<thead>
<tr>
<th>Color</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gray ramus</td>
</tr>
<tr>
<td></td>
<td>Sympathetic trunk</td>
</tr>
<tr>
<td></td>
<td>Superior cervical ganglion</td>
</tr>
<tr>
<td></td>
<td>Middle cervical ganglion</td>
</tr>
<tr>
<td></td>
<td>Inferior cervical ganglion</td>
</tr>
<tr>
<td></td>
<td>Ventral rami</td>
</tr>
<tr>
<td></td>
<td>Internal carotid nerve</td>
</tr>
<tr>
<td></td>
<td>External carotid nerve</td>
</tr>
<tr>
<td></td>
<td>Fibers to carotid body</td>
</tr>
<tr>
<td></td>
<td>Cardiac branches</td>
</tr>
<tr>
<td></td>
<td>Ansa subclavia</td>
</tr>
<tr>
<td></td>
<td>Vertebral nerve</td>
</tr>
<tr>
<td></td>
<td>Subclavian/axillary nerve</td>
</tr>
</tbody>
</table>

Underline all the nerves and ganglia above that contain preganglionic efferent neurons.
Clearly and completely describe each of the following:

Greater splanchnic nerve

Lesser splanchnic nerve

Least splanchnic nerve

Superior hypogastric plexus

Inferior hypogastric plexus

Celiac ganglion

Aorticorenal ganglion

Inferior mesenteric ganglion
**Parasympathetic Nerves**

Draw and label the basic plan of the parasympathetic nerve pathways.

How many nerves, which arise directly from the central nervous system, carry parasympathetic preganglionic efferent neurons? List them by name.
**EXERCISES - MEDIASTINUM AND SURFACE ANATOMY**

**The Mediastinal Pattern**

On the cross section of the embryonic thorax illustrated below, draw and label horizontal lines that depict the anatomical planes of the mediastinum.

List all the structures that are in the superior mediastinum.

List all the structures that are in the posterior mediastinum.
**Key Levels**

For each of the vertebral levels below, state all the structures of the mediastinum that would be transected by a horizontal plane passing through the level.

Thoracic vertebra 2

Thoracic vertebra 4

Thoracic vertebra 6

Thoracic vertebra 8

Thoracic vertebra 10

Thoracic vertebra 12

For each of the vertebral levels below, state the sternal landmark that sits on the same horizontal plane.

Thoracic vertebra 2

Thoracic vertebra 4

Thoracic vertebra 9 to 10
The Cervical Plexus

Draw and label the cervical plexus and try to add the smaller detailed branches.
**Distribution of the Cervical Plexus**

List the four large, lateral cutaneous branches of the cervical plexus in the spaces below. For each nerve describe the spinal nerve levels that contribute to the nerve and its pathway in the head and/or neck. On the illustration of the head and neck below, clearly outline the cutaneous field of each of these nerves.

1.

2.

3.

4.

While the punctum nervosum is not a sanctioned anatomical term, it is a term used by surgeons. Clearly describe the punctum nervosum.
Exercises - Cervical Plexus

Using simple logic, explain why it is easy to understand the muscular branches of the cervical plexus, that is, what muscles do they innervate and why is this so logical.

In which fascial compartment are all the deep muscular branches of the cervical plexus located. Clearly describe why you chose this answer.

Explain why the diaphragm, a muscle located at the inferior aspect of the thorax, is innervated by the phrenic nerve, which arises from the cervical plexus. Which level of the cervical plexus is the major contributor to the phrenic nerve?
Describe the peripheral course of the following nerves. Your description should describe the origin of the nerve, all key anatomical associations it makes throughout its course with surrounding structures, all branches of the nerve, and the terminal distribution of the nerve and its branches. Your answer should be in the form of a bulleted list.

- Lesser occipital nerve

- Great auricular nerve

- Transverse (anterior) cutaneous nerve of the neck

- Supraclavicular nerve

- Phrenic nerve
The Brachial Plexus

Draw and label all the named parts of the brachial plexus and try to add the smaller detailed branches.
Brachial Plexus Variations and Topography

Describe a prefixed plexus

Describe a postfixed plexus

Clearly describe the location and relation to surrounding structures of each part of the brachial plexus listed below.

Roots of the plexus

Trunks of the plexus

Divisions of the plexus

Cords of the plexus
**Muscular Distribution of Brachial Plexus**

If you can fill in the table below you will have a strong overall working knowledge of the muscular innervation of the upper limb to use in problem solving situations.

<table>
<thead>
<tr>
<th>Spinal Nerve Level</th>
<th>Muscle Group Innervated</th>
<th>Nerves Distributing Neurons</th>
<th>Muscles Innervated by each Nerve (if multiple nerves then clearly pair the muscles listed to the nerves in the previous column)</th>
<th>Joint Actions to Test Denervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>C8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cutaneous Distribution of Brachial Plexus

Clearly describe the difference between the dermatomes of the upper limb and the cutaneous nerves of the upper limb.

On the outlines of the upper limb below (anterior view on the left below and posterior view on the right below), clearly outline the areas where you would test for a sensory lesion for each spinal level contributing to the brachial plexus and where you would test for sensory lesion for each cutaneous branch of the brachial plexus.

Spinal levels

Cutaneous nerves
Anatomy of the Terminal Branches

Describe the peripheral course of the following nerves. Your description should describe the origin of the nerve, all key anatomical associations it makes throughout its course with surrounding structures, all branches of the nerve, and the terminal distribution of the nerve and its branches. Your answer should be in the form of a bulleted list.

- Musculocutaneous nerve
- Axillary nerve
- Median nerve
Describe the peripheral course of the following nerves. Your description should describe the origin of the nerve, all key
anatomical associations it makes throughout its course with surrounding structures, all branches of the nerve, and the
terminal distribution of the nerve and its branches. Your answer should be in the form of a bulleted list.

Ulnar nerve

Radial
The Basic Pattern of the Ventral Ramus

In a column below, clearly list all the branches you would expect to find on the basic plan of a ventral ramus. Label each of the branches in your list on the illustrations below.
**Intercostal Nerves**

Clearly describe how each of the following nerves differs from the basic pattern of the ventral ramus that you listed and labeled on the previous page.

- Intercostal nerve T1

- Intercostal nerves T2 to T6

- Intercostal nerves T7 to T11

- Subcostal nerve T12
Exercises - Lumbosacral Plexus Anatomy

The Lumbar Plexus

Draw and label all the named parts of the lumbar plexus and try to add the smaller detailed branches.
The Sacral Plexus

Draw and label all the named parts of the sacral plexus and try to add the smaller detailed branches.
Lumbar Plexus Variations and Topography

Describe a prefixed plexus. How does this differ from a prefixed brachial plexus?

Describe a postfixed plexus. How does this differ from a postfixed brachial plexus?

Be able to do the following for the accessory obturator nerve:

- Describe its prevalence.

- Describe its innervation.

- Describe its course.

Lumbar Plexus Topography

Describe the relation of the lumbar plexus and the psoas major muscle. Describe the clinical significance of this relationship.

As the body wall nerves of the lumbar plexus pass into the body wall, how do they differ from other body wall nerves, such as the intercostal nerves?
Anatomy of the Abdominal Wall and Inguinal Region

Clearly define each of the following structures and clearly label them on the illustrations on this and the following page:

- Semilunar line
- Linea alba
- Arcuate line
- Inguinal ligament
- Lacunar ligament
- Reflected ligament
- Deep inguinal ring
- Superficial inguinal ring
- Falx inguinalis
- Transversalis fascia
- Femoral sheath
- Femoral canal
Exercises - Lumbosacral Plexus Anatomy
Anatomy of the Spermatic Cord and Scrotum

Clearly label all the anatomy visible in this illustration. Your labels should include structures of the abdominal wall and structures of the spermatic cord and scrotum.

Topography and Relations of the Sacral Plexus

Clearly define the following:

Lumbosacral trunk

Upper bands of the sacral plexus

Lower bands of the sacral plexus.

Superior and inferior piriform foramina
### Distribution of the Lumbar and Sacral Plexus Nerves

For **each of the named nerves** of the lumbar and sacral plexus, you should be able to trace their pathway from their origin in the spinal cord to their terminal distribution to muscle and skin. You should be able to describe important anatomical relationships they form in this pathway through the body. The following are a couple of examples to try, but you should feel free to make up your own examples to practice with.

You have an itch on the posterior aspect of your calf in the location indicated by the “X” on the illustration. Trace the sensory neuron through **all the nervous pathways** it takes on its path to the spinal cord in the Column 1 and describe the key anatomical relationships of the nervous pathways in your trace in the Column 2.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image_url" alt="Illustration" /></td>
<td><img src="image_url" alt="Illustration" /></td>
</tr>
</tbody>
</table>
Trace a neuron from its origin in the spinal cord along its dominant level to the extensors of the knee. Trace the motor neuron through all the nervous pathways it takes on its path from the spinal cord to the muscles in the Column 1 and describe the key anatomical relationships of the nervous pathways in your trace in the Column 2.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Spinal Level Distribution of Lumbosacral Plexus

For each spinal level below, clearly state the muscular tests you would perform to ascertain that a lesion was at that level and not on a named nerve.

L1

L2

L3

L4

L5

S1

S2

S3
Cutaneous Distribution of Lumbosacral Plexus

On the outlines of the lower limb below (anterior view on the left and posterior view on the right), clearly draw the dermatomes.
On the outlines of the lower limb below (anterior view on the left below and posterior view on the right below), clearly label all the cutaneous fields.