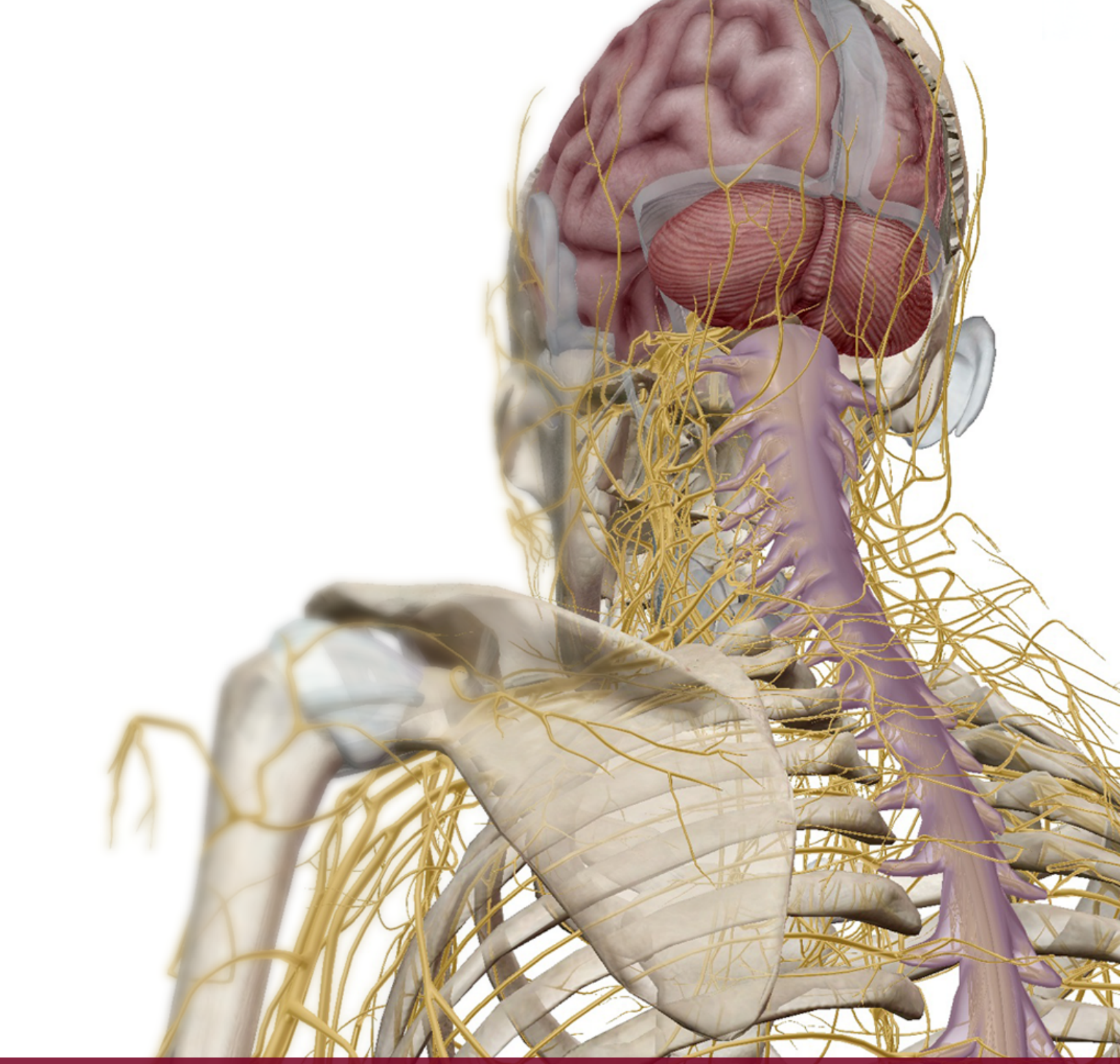

VISIBLE BODY®

The Spinal Cord & Spinal Nerves

A nervous system lab activity using Visible Body Suite

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PRE-LAB EXERCISES

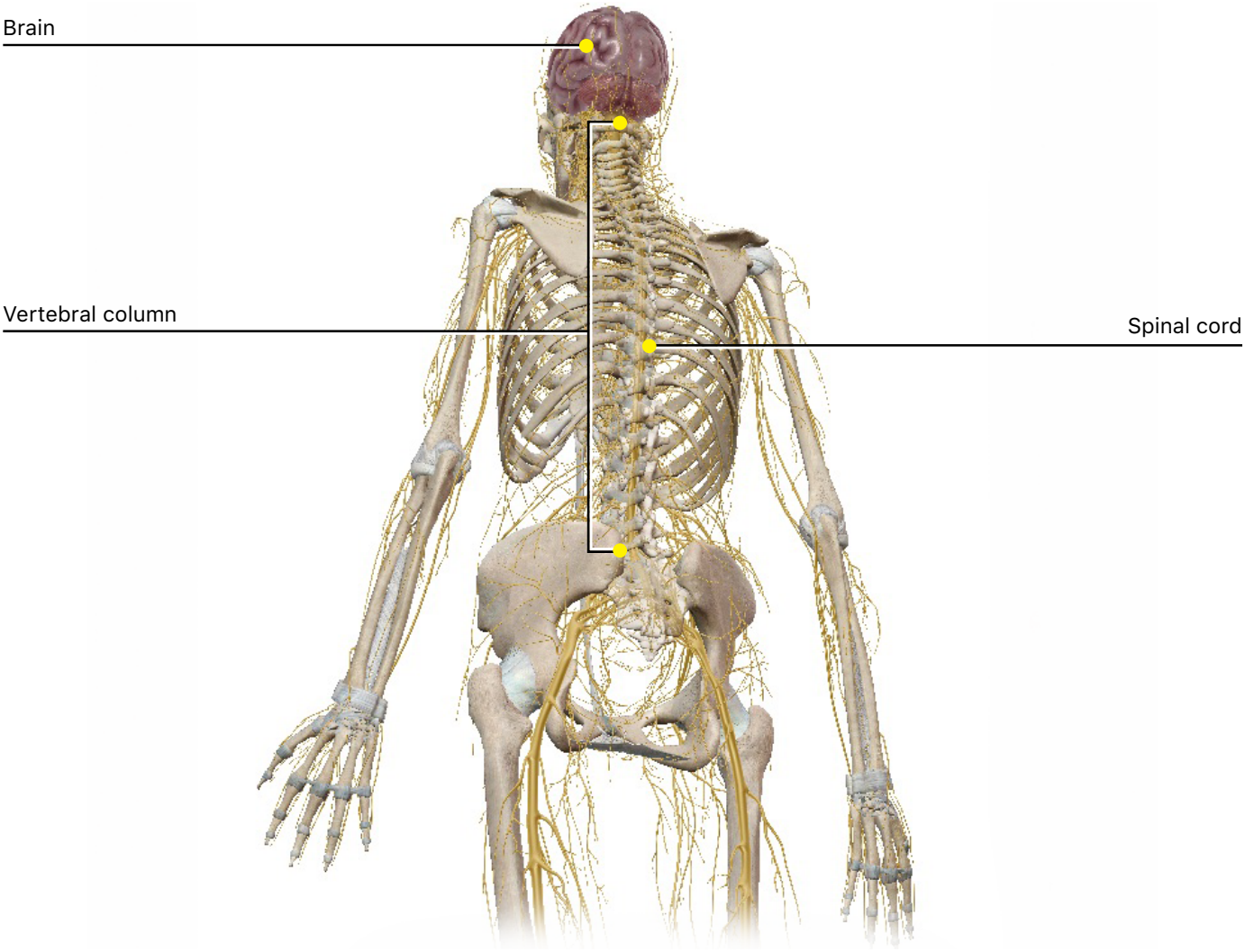
When studying the spinal cord and spinal nerves, it's important to know how to distinguish between the following key structures.

- Neurons: Nervous system cells that conduct electrical signals via axons
- Axons: Neuronal processes that connect with different neurons, muscles, and glands
- Nerves: Bundles of axons that travel together in the peripheral nervous system
- Tracts: Bundles of axons that travel together in the central nervous system
- Descending tracts: Bundles of axons that carry motor signals down the spinal cord before leaving the spinal cord and entering the ventral roots
- Ascending tracts: Bundles of axons that carry sensory signals up the spinal cord toward the brain
- Association neurons: Cells of the CNS that integrate incoming information and decide which responses (if any) are required
- Fibers: This generic term can refer to either axons or nerves in the nervous system.

Open Visible Body Suite. From the main menu, choose Anatomy & Physiology and select Nervous System and Special Senses.

You are responsible for the identification of **all bold terms**.

A. Explore the 3D anatomical view in Module 17.3 Central Nervous System and answer the following questions.



1. The **nervous system** is anatomically separated into two parts. The _____ and the _____ make up the **central nervous system (CNS)**.

2. Together, the brain and spinal cord function as the body's _____.

3. Select the **spinal cord** from the left-side menu and use the book icon to read its definition.

    a. The spinal cord is found within the **spinal canal** of the _____.

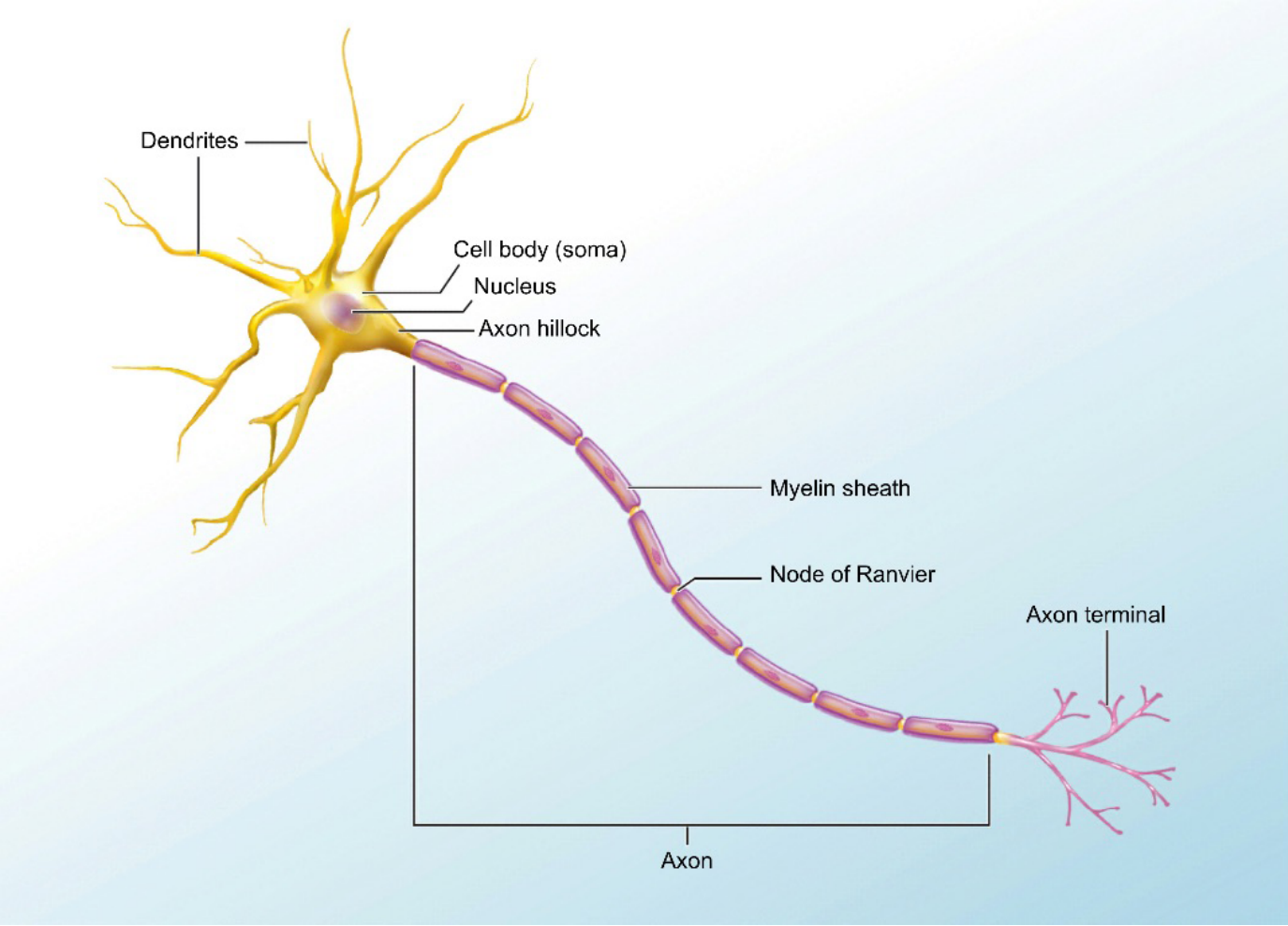
b. The spinal cord extends from the upper border of the _____ to the lower border of the first, or upper border of the second, _____.

c. Above the **vertebral (spinal) column**, the spinal cord is continuous with the _____.

d. In the **lumbar region**, the spinal cord ends in a conical extremity called the _____.

e. Like the brain, the spinal cord is surrounded by three connective tissue layers, or membranes, called _____.

B. Open the illustration slideshow in Module 18.2 Neuron Histology, examine Slide 1 – Neuron Structure, and answer the following questions. (Note: You can also use the dots under the image to examine a series of histology micrographs and learn about how the structure of myelinated and unmyelinated axons facilitates their functions.)



1. The nervous system cells that transmit signals are called _____.

2. The region of a **neuron** that contains the nucleus is called the _____.

3. The neuronal processes that receive information are called _____.

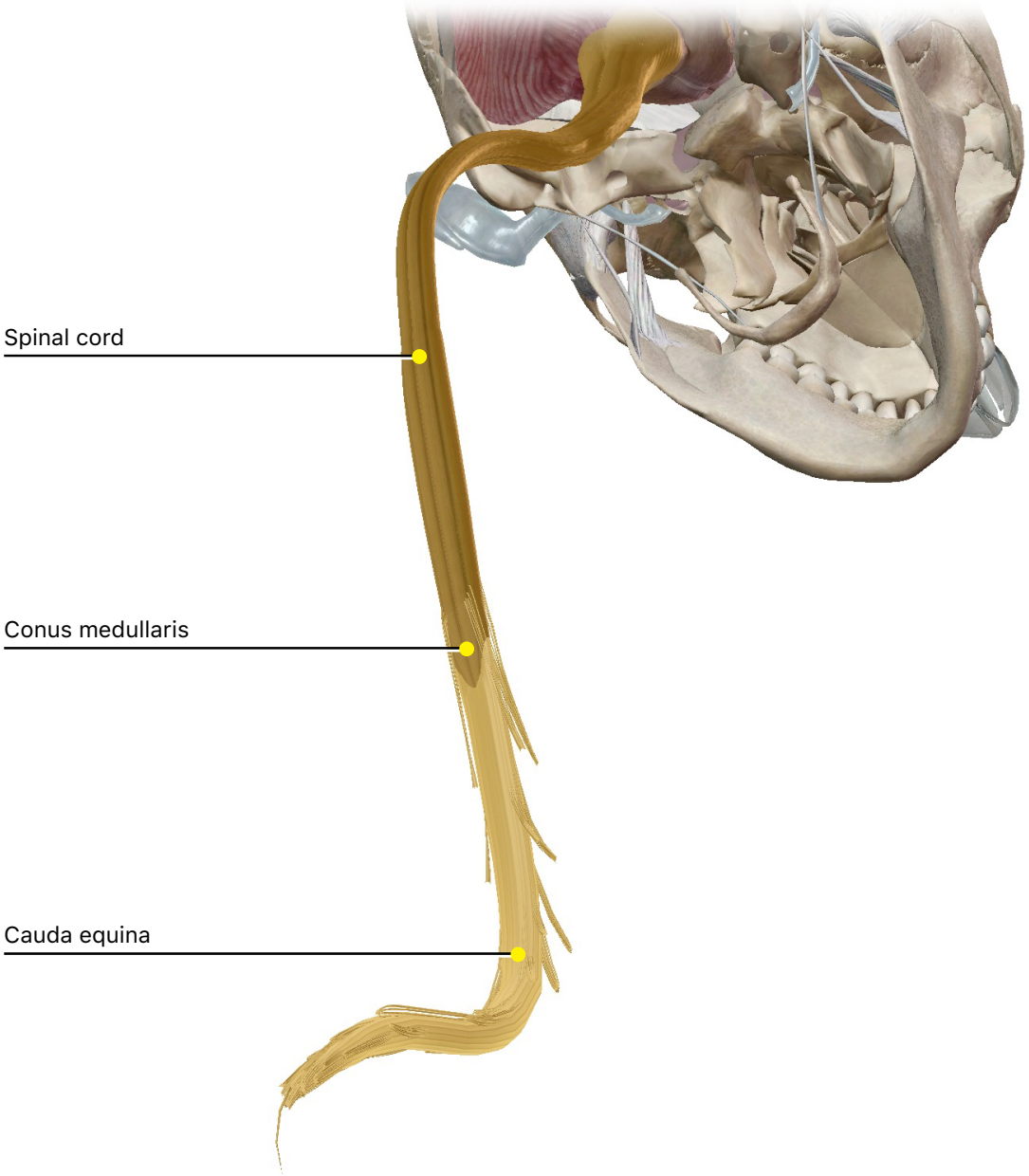
4. The neuronal process that generates and transmits electrical signals is called the _____.
(Fun fact: The generic term for a neuronal process is "neurite.")

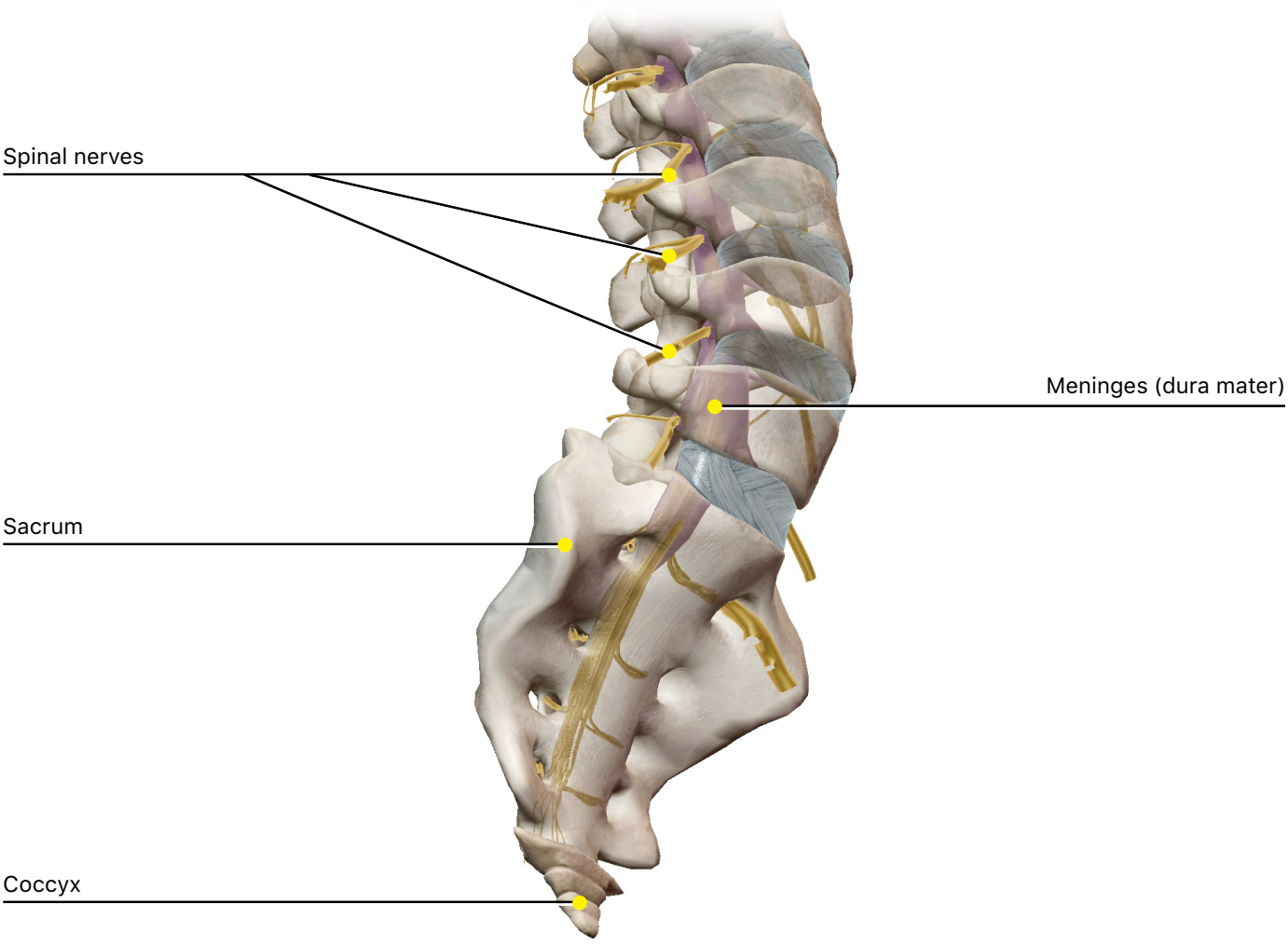
IN-LAB EXERCISES:

Use the following modules in the Anatomy & Physiology section of Visible Body Suite to guide your exploration of the spinal cord and spinal nerves. Be sure to select the book icon under the structure names to learn more about the structures you are exploring.

You are responsible for the identification of **all bold terms** and all answers to the questions.

A. Explore the 3D anatomical view in Module 19.1 Spinal Cord and answer the following questions.





1. Select the spinal cord from the left-side menu and use the book icon to read its definition.

    a. The spinal cord contains two basic types of cells, the _____ and _____.

    b. The spinal cord ends in the _____ region, but fibers extend from there to lower regions of the spinal canal.

    c. The spinal cord ends in a conical structure called the _____. Fibers from the lower end of the spinal cord form the _____, which extends to the **coccyx**.

2. Refresh the view and double tap the sacrum at the bottom of the spine. Use the Hide tool to remove the sacrum from the view. Locate the **cauda equina** (meaning "horse's tail" in Latin) and the very thin **filum terminale** that extends to the coccyx. What forms these structures?

*Note: Because the lower regions of the spinal canal do not contain any spinal cord, it is safe to sample CSF from here using a procedure called a **spinal tap**.*

3. Select the **meninges** from the left-side menu and use the book icon to read their definition.

a. From innermost to outermost, list the three meninges that protect the spinal cord.

b. Between the outermost meninges and the **vertebral canal** is the _____ space, which contains loose areolar connective tissue, adipose tissue, and blood vessels. *(Hint: When someone gets an "epidural," the injection is delivered into this space.)*

c. With the meninges selected, pan the view to see their full extent. How far down the spinal column do the meninges extend?

4. Select the vertebral column from the left-side menu and use the book icon to read its definition.

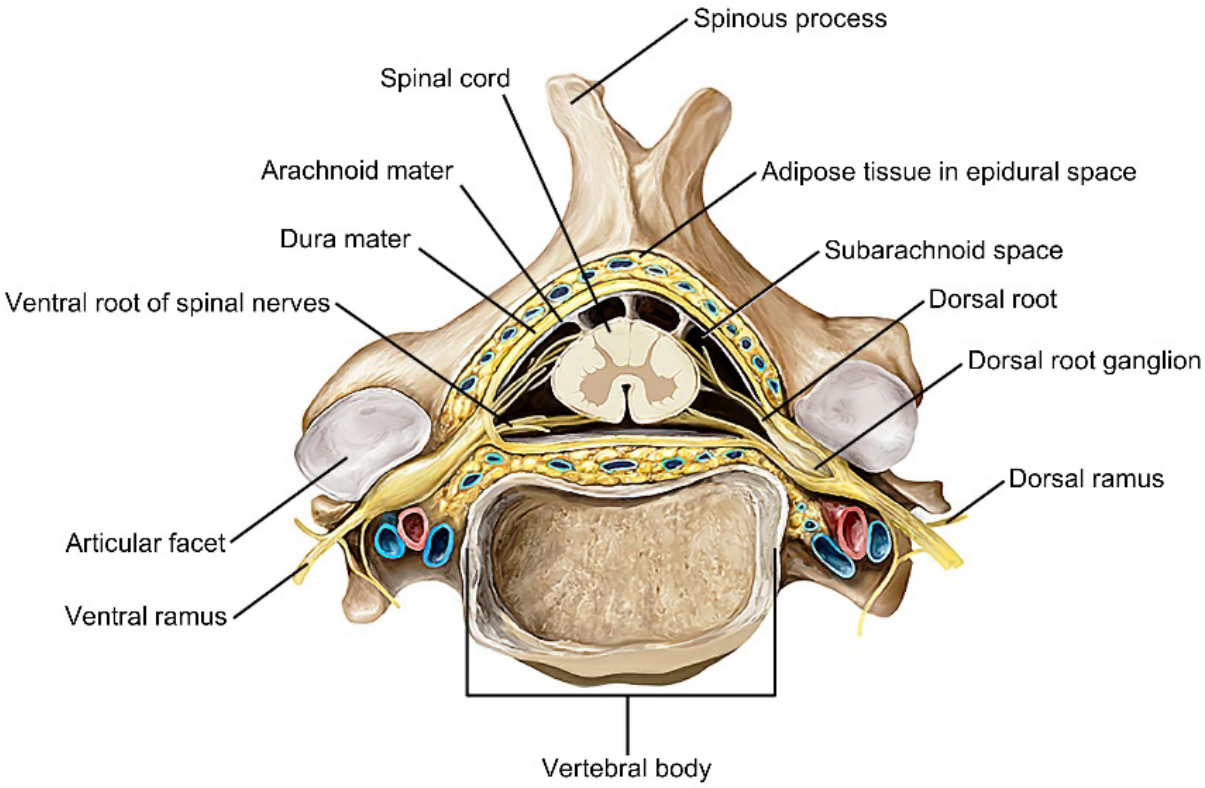
a. Regions of the spinal cord are named for the regions of the **vertebral column** (spinal column) they occupy. What are the five regional groupings of **vertebrae**?

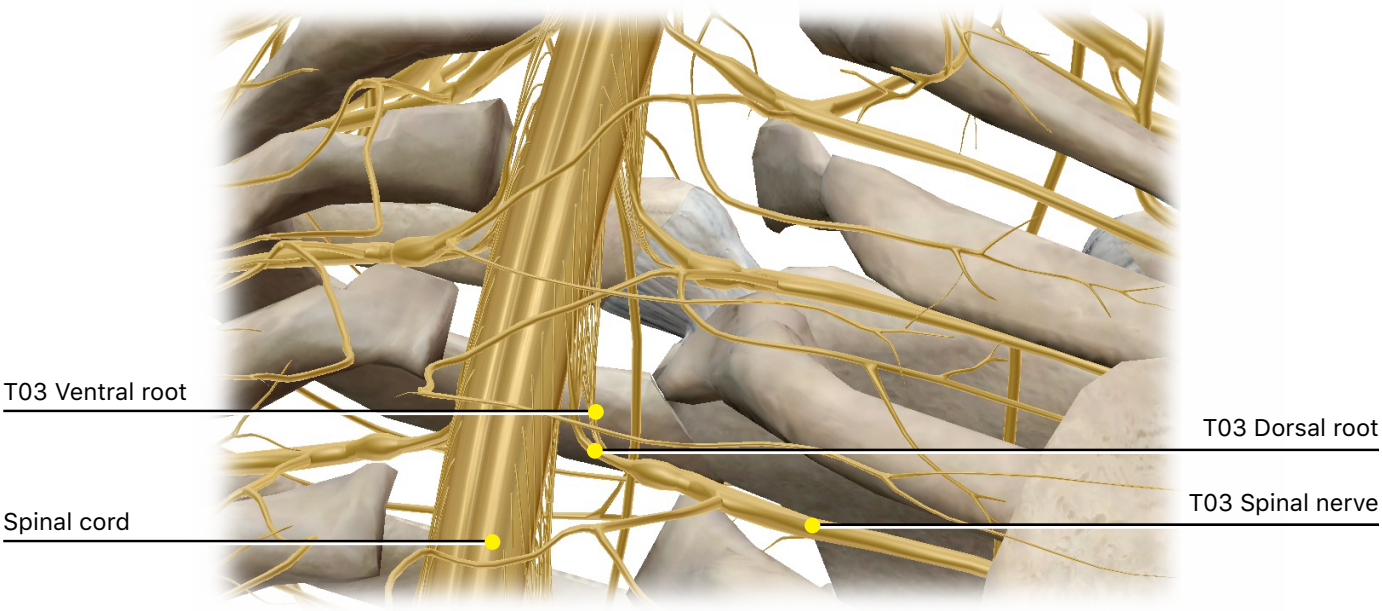
b. Which of these regions contains the spinal cord?

c. The spinal cord passes through channels in the vertebrae called _____.

d. **Spinal nerves**, which leave the spinal cord and enter the periphery, pass though apertures in the vertebral column called _____.

B. Examine the illustration in Module 19.2 Spine Cross Section and explore the 3D anatomical views in Modules 19.3 Spinal Nerve Roots, 19.5 Sensory Signals, and 19.6 Motor Commands. Use these modules to answer the following questions.





1. In Module 19.2 Spine Cross Section, observe how the spinal nerves leave the spinal cord as left and right pairs of **roots**. On the posterior side of the spinal cord are the _____ roots and on the anterior side are the_____ roots.

2. The roots join to leave the spinal cord as spinal nerves on either side. As soon as they exit the vertebral column, they branch into dorsal and ventral _____, which branch further to supply the entire body.

3. In the following image, label the **epidural space**, **dura mater**, **arachnoid mater**, and **subarachnoid space**.

4. Use the right arrow at the bottom of the left-side menu to open Module 19.3 Spinal Nerve Roots. *(Note: You can also refer to the 3D anatomical views in Modules 19.5 Sensory Signals and 19.6 Motor Commands to help you answer the following questions).*

a. What is the function of the spinal nerves?

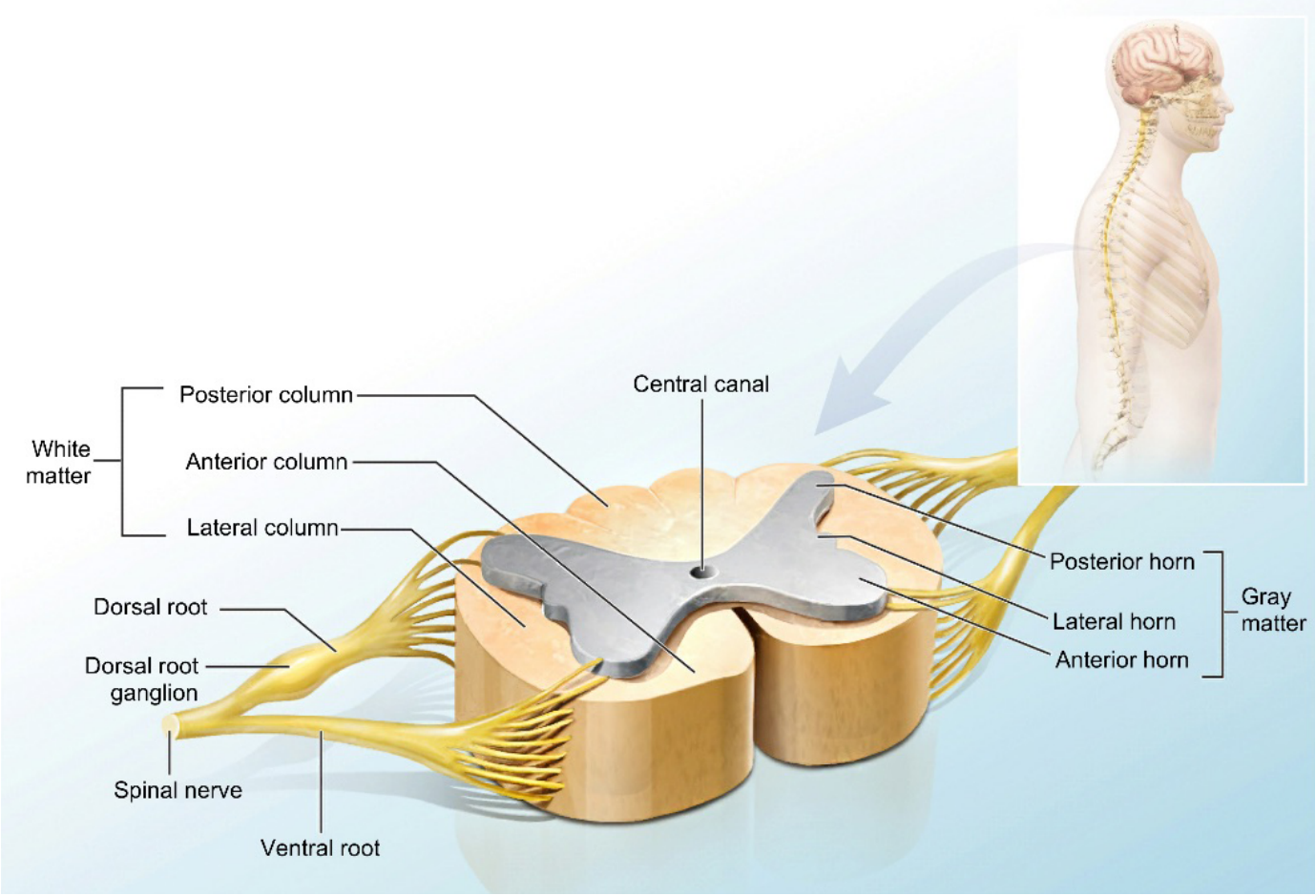
b. Select the spinal nerves from the left-side menu. The spinal nerves and their branches supply the entire body and make up most of the **peripheral nervous system**. Select the **dorsal roots** from the left-side menu to highlight them in the view. The dorsal roots transmit _____ signals.

c. Motor commands (motor signals) originate in the CNS and travel down the spinal cord toward the periphery to trigger an action. Actions are either _____ or _____.

d. Select the **ventral roots** from the left-side menu to highlight them in the view. The ventral roots transmit _____, or **efferent**, signals from the CNS.

e. Select the dorsal root **ganglia** from the left-side menu to highlight them in the view. Ganglia are collections of _____ that process incoming, or **afferent**, signals from the periphery.

C. Explore the illustration slideshow in Module 19.4 Spinal Cord Histology and answer the following questions.



1. First, examine the illustration in Slide 1 – Gray and White Matter to learn about how spinal cord tissue forms two regions that are named for their color. As you answer the following questions, keep in mind that because humans walk on two legs and face forward, "ventral" and "anterior" are synonymous, as are "dorsal" and "posterior."

a. The butterfly-shaped (H-shaped) area in the center of the spinal cord consists of _____. Each lateral "wing" forms three _____.

i. What are the names of these three structures?

ii. What are the functions of these structures?

b. Surrounding the **gray matter** is the _____ matter.

i. This tissue is organized into _____ that send signals up and down the spinal cord. *(Note: They are so-named because groups of axons that travel together through the spinal cord are bundled into column-shaped groups.)*

ii. Locate the three **columns** of **white matter** on either side of the spinal cord. These are the _____ columns.

c. Branches of the dorsal roots join with the _____ gray horns and branches of the ventral roots join with the _____ gray horns.

2. Click on the forward arrow under under the image to examine the micrographic image in Slide 2 – Gray Matter: Anterior Horn.

a. What does gray matter consist of?

b. The **posterior horns** consist of _____ that receive sensory input from axons conveying information about _____.

c. The **anterior horns** consist of _____ that facilitate _____ movement.

d. The left and right gray matter horns are connected by the _____. Find this structure in the image.

e. In the very center of the gray matter is a fluid-filled, tube-shaped space called the _____ that runs through the entire spinal cord. The fluid inside this space is called _____.

f. **Lateral horns** consist of _____ that supply the _____. They are found only in the _____ and _____ regions of the spinal cord.

3. Click on the forward arrow under the image to examine the micrographic image in Slide 3 – White Matter.

a. What does white matter consist of?

b. What gives white matter its color?

c. Axons carrying signals up the spinal cord, toward the brain, are called _____ axons. Axons carrying signals down the spinal cord, toward the periphery, are called _____axons.

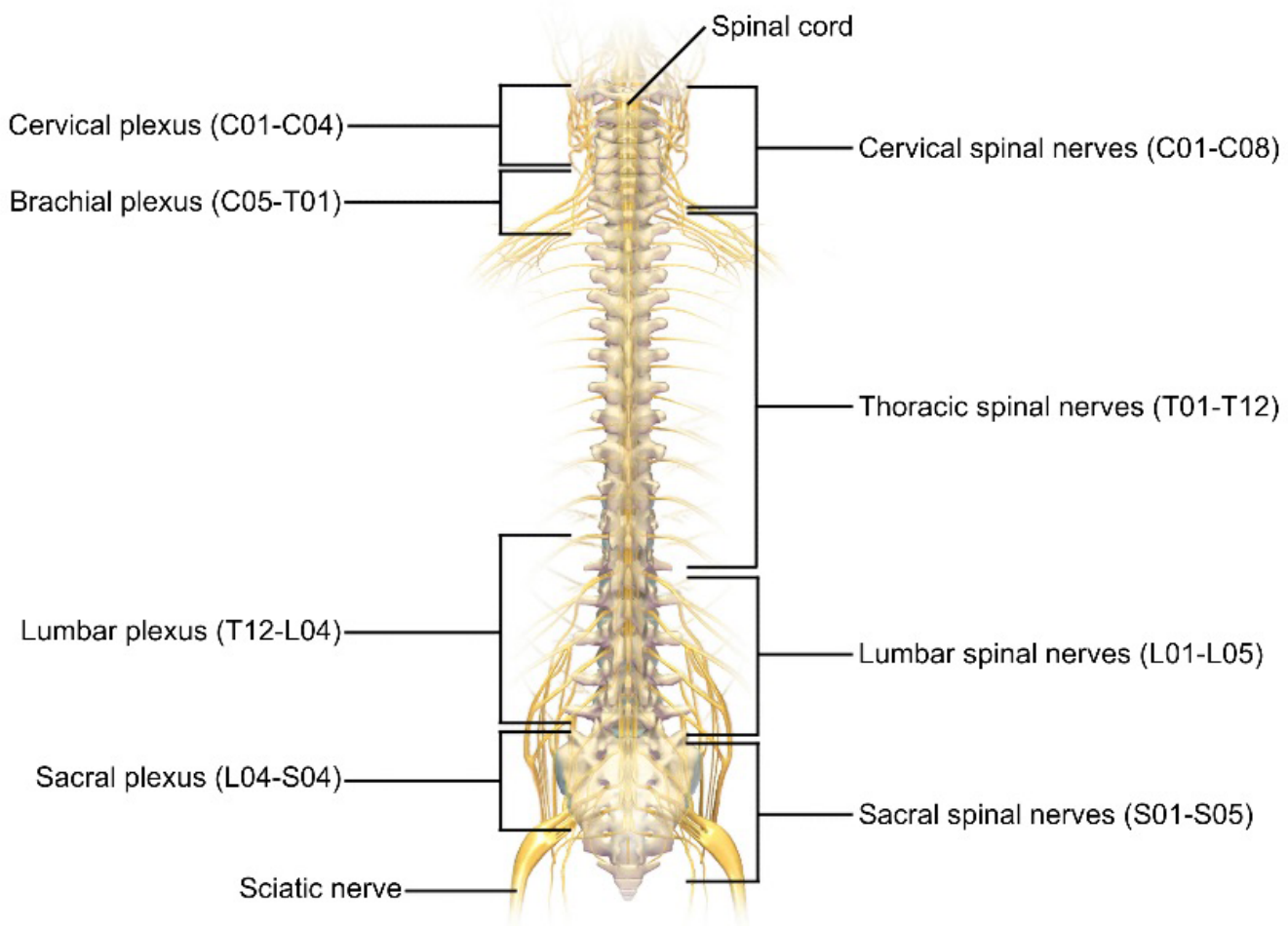
d. In the following statements, circle the correct answers.

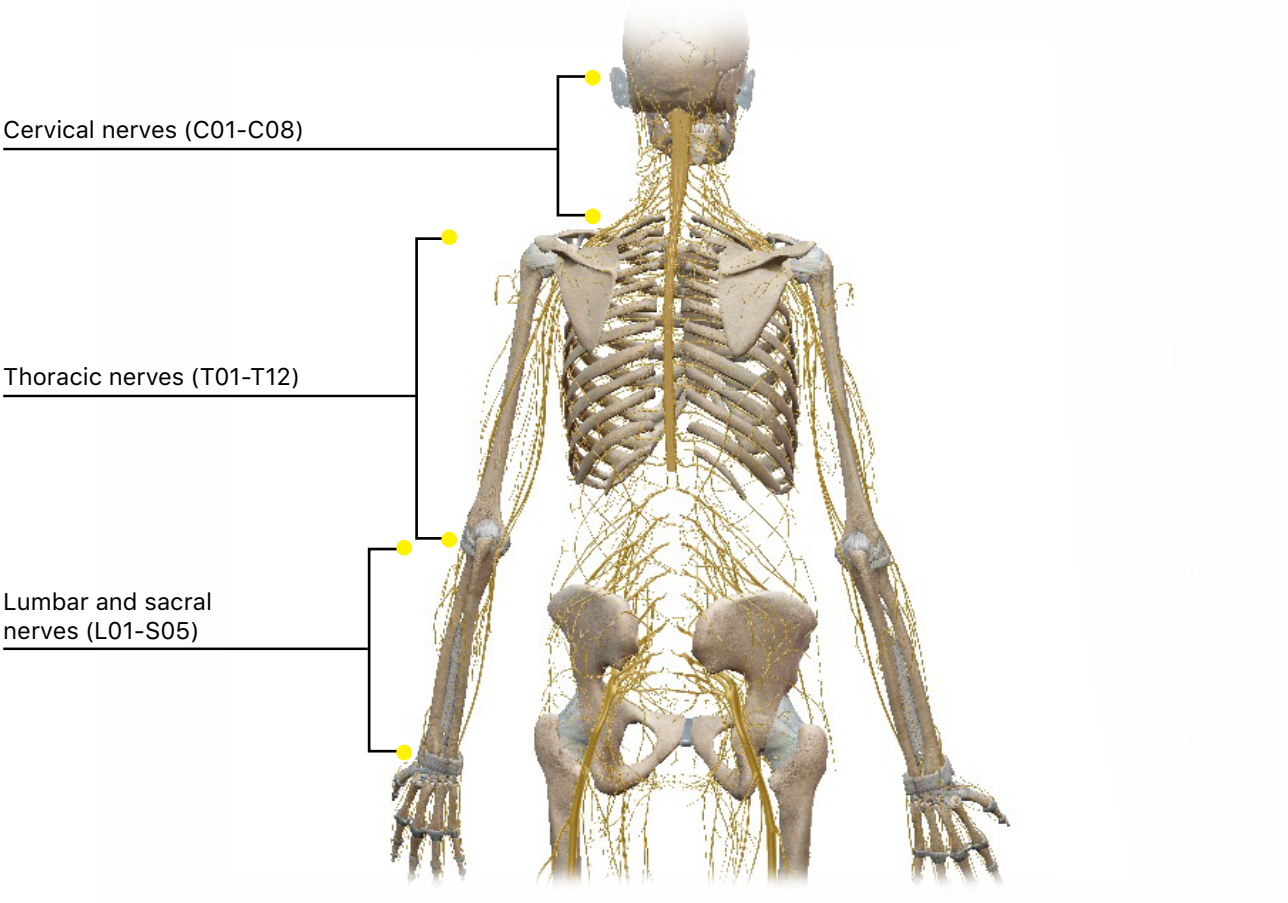
Motor signals are carried by ascending / descending axons.

Sensory signals are carried by ascending / descending axons.

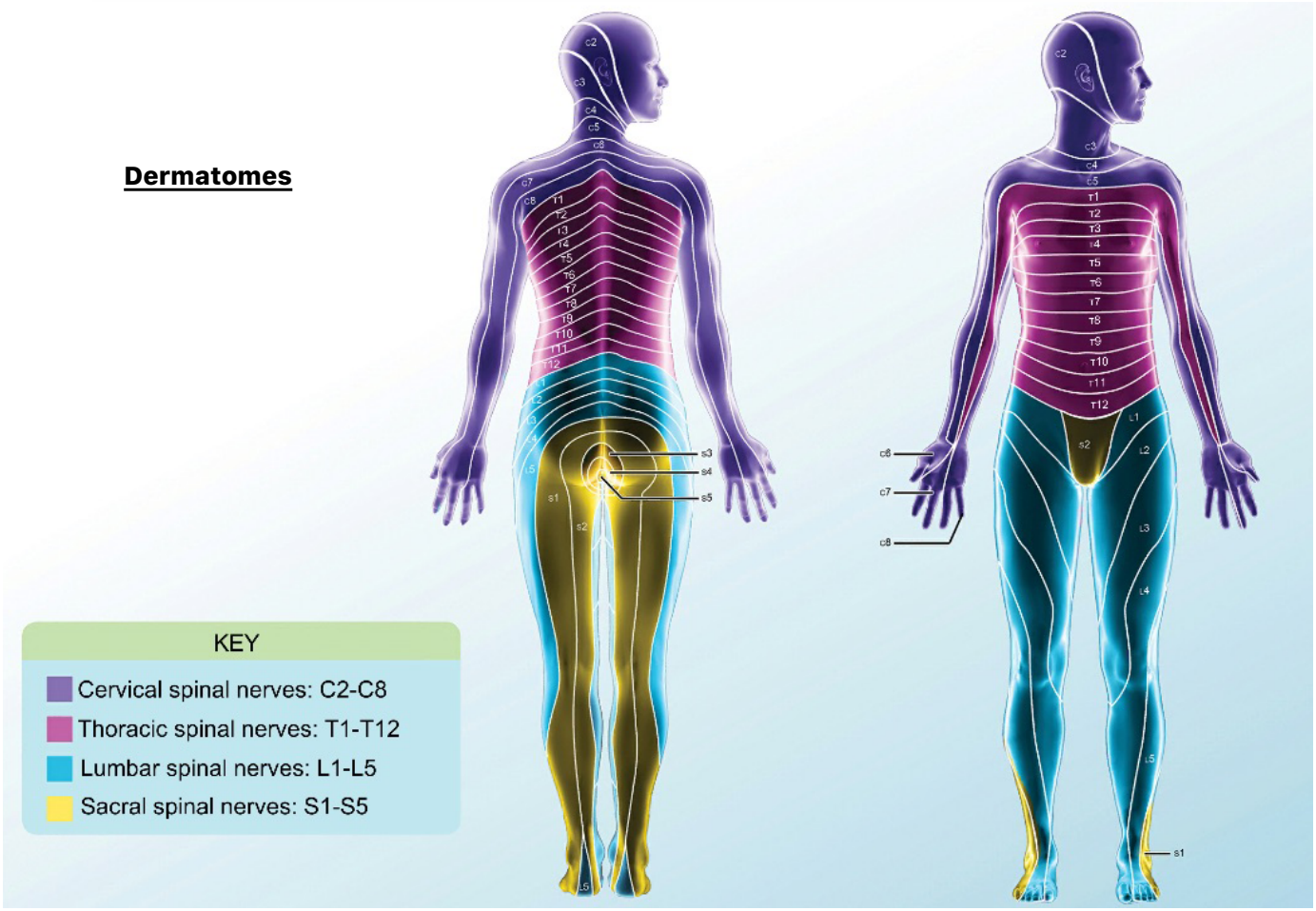
e. Axons that cross from one side of the spinal cord to the other are called _____.

D. Examine the illustrations in Modules 19.7 Spinal Nerves and 19.9 Dermatomes, explore the 3D anatomical view in Module 19.8 Spinal Nerve Regions, and answer the following questions.




Cervical nerves (C01-C08)
Thoracic nerves (T01-T12)
Lumbar and sacral nerves (L01-S05)

Dermatomes


KEY
Cervical spinal nerves: C2-C8
Thoracic spinal nerves: T1-T12
Lumbar spinal nerves: L1-L5
Sacral spinal nerves: S1-S5

1. In Module 19.7 Spinal Nerves, observe how spinal nerves are organized according to the regions of the _____ from which they arise.

2. Many spinal nerves form **anastomosing** networks called _____ that innervate specific regions of the body. In the following statements, fill in the blanks.

a. The _____ plexus innervates the neck and thoracic regions.

b. The **brachial plexus** innervates the _____.

c. The _____ and _____ **plexuses** innervate the lower limbs and the pelvis. These two plexuses are often grouped together and called the _____.

3. Use the right arrow at the bottom of the left-side menu to open Module 19.8 Spinal Nerve Regions. Spinal region names are usually abbreviated. For example, the fifth cervical nerve is abbreviated as "C5" or "C05."

a. There are _____ pairs of cervical nerves, _____ pairs of thoracic nerves, _____ pairs of lumbar nerves and _____ pairs of sacral nerves.

b. What is the abbreviation for the tenth thoracic spinal nerve?

c. Which spinal nerves innervate the neck?

d. Which spinal nerves innervate the regions between the ribs?

e. Which spinal nerves innervate the feet?

4. Use the right arrow at the bottom of the left-side menu to open Module 19.9 Dermatomes.

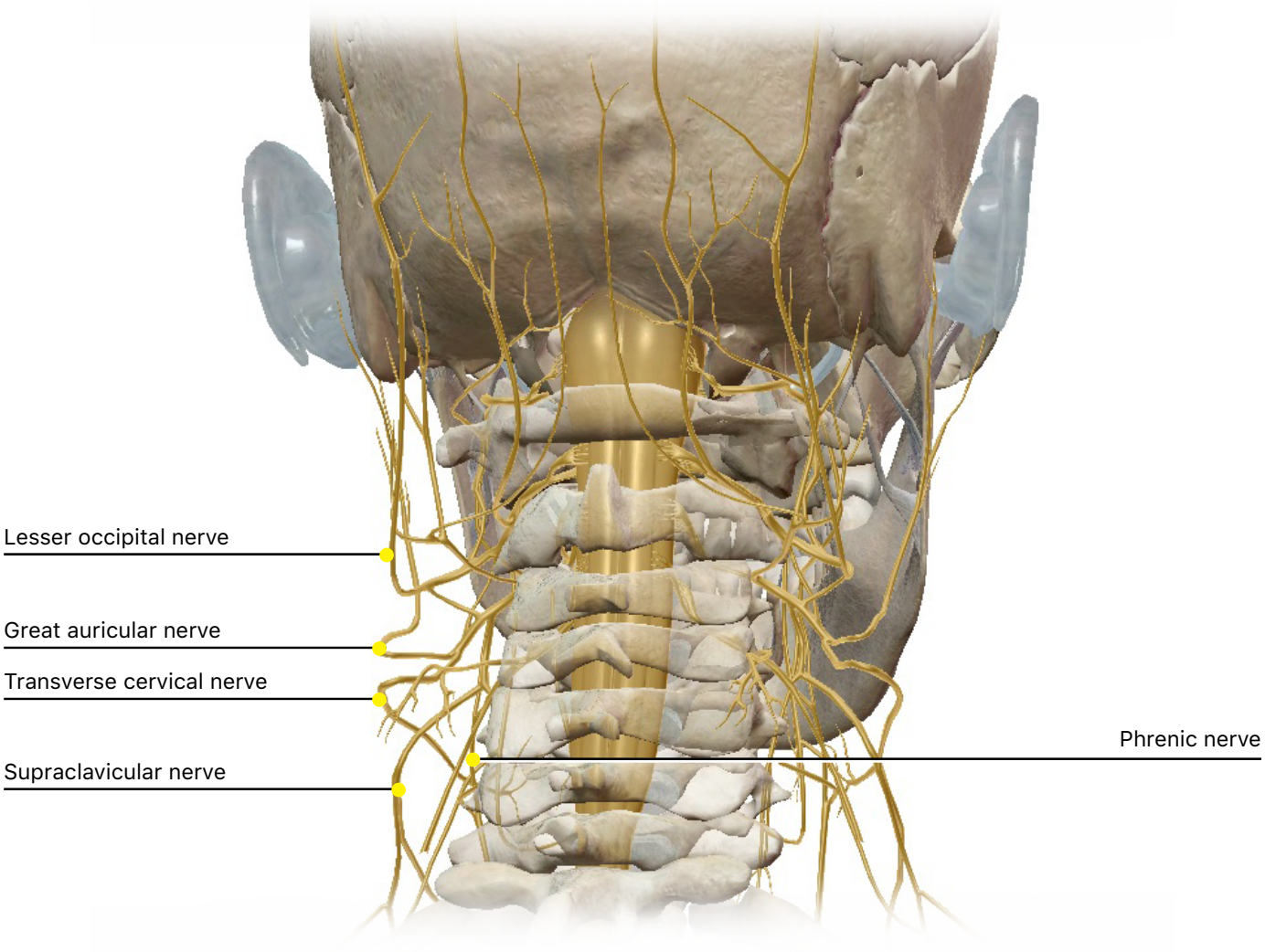
a. What is a **dermatome**?

b. What does “derma-” mean?

c. All the spinal nerves carry sensory fibers from the skin except _____. The sensory input from the skin of the facial region travels along _____, which is also called the _____ nerve. *(Note: Chickenpox is caused by the varicella zoster virus. Some of the virus can lodge inside spinal nerves and reappear years later, as they become reactivated and travel down the axons to erupt into the dermatome served by that nerve. It is an extremely painful disease.)*

i. The dermatome that includes the little finger is innervated by _____.

E. Explore the 3D anatomical views in Modules 19.10 Cervical Plexus and 19.11 Cervical Innervation and answer the following questions.



1. In Module 19.10 Cervical Plexus, select the **cervical plexus** from the left-side menu and use the book icon to read its definition. (Note: You can refer to Module 19.11 Cervical Innervation to observe the structures that are innervated by the cervical plexus nerves.)

a. The cervical plexus derives from the _____ rami of spinal nerves _____.

b. The cervical plexus supplies the skin and muscles of the _____.

c. C01 is also called the _____. It supplies _____.

d. The cervical plexus contains two groups of branches: the _____ and the _____.

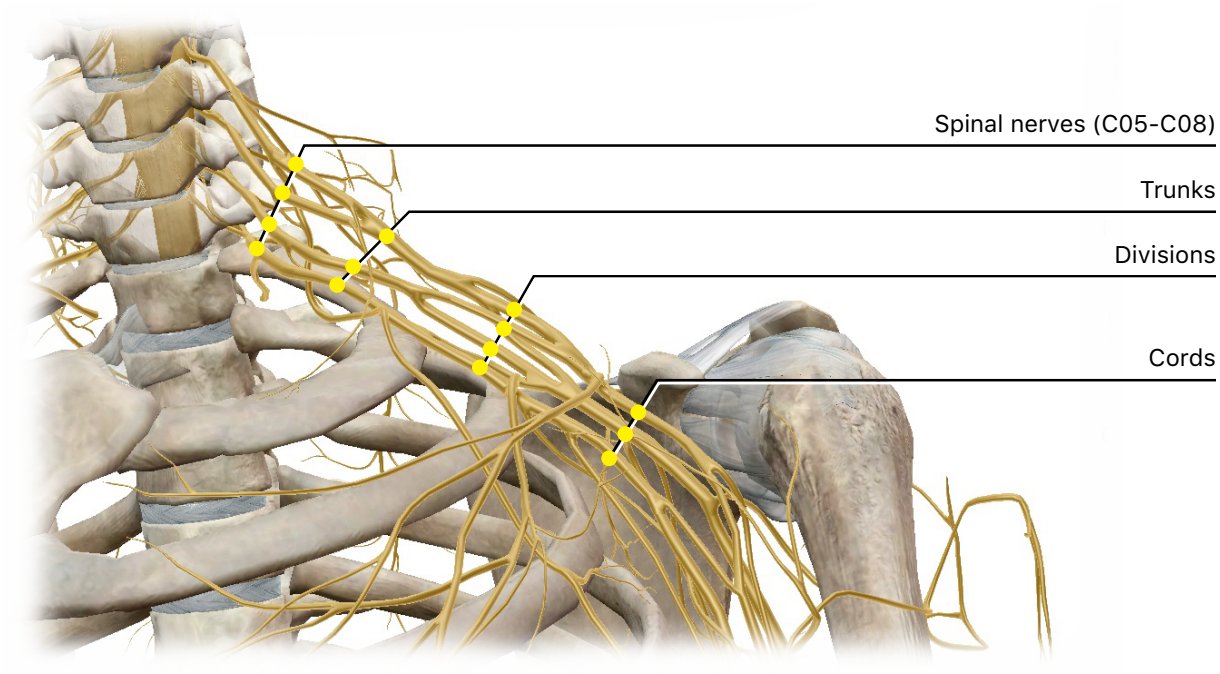
e. In the following statement, circle the correct answer: Most branches of the cervical plexus supply the **skin / muscles / bones / glands.**

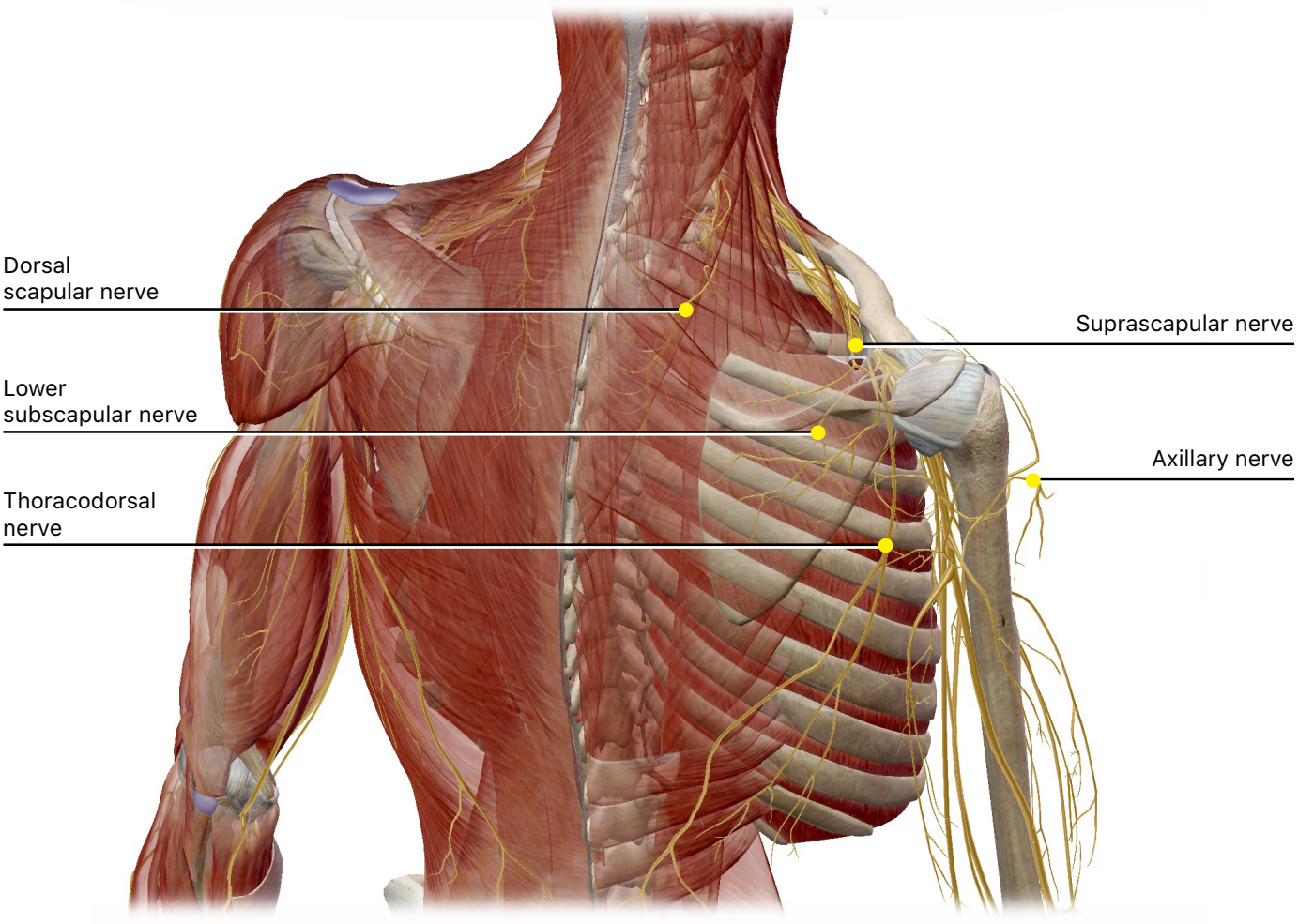
f. The _____ nerve contains both sensory and motor fibers. It supplies the _____and is important for _____.

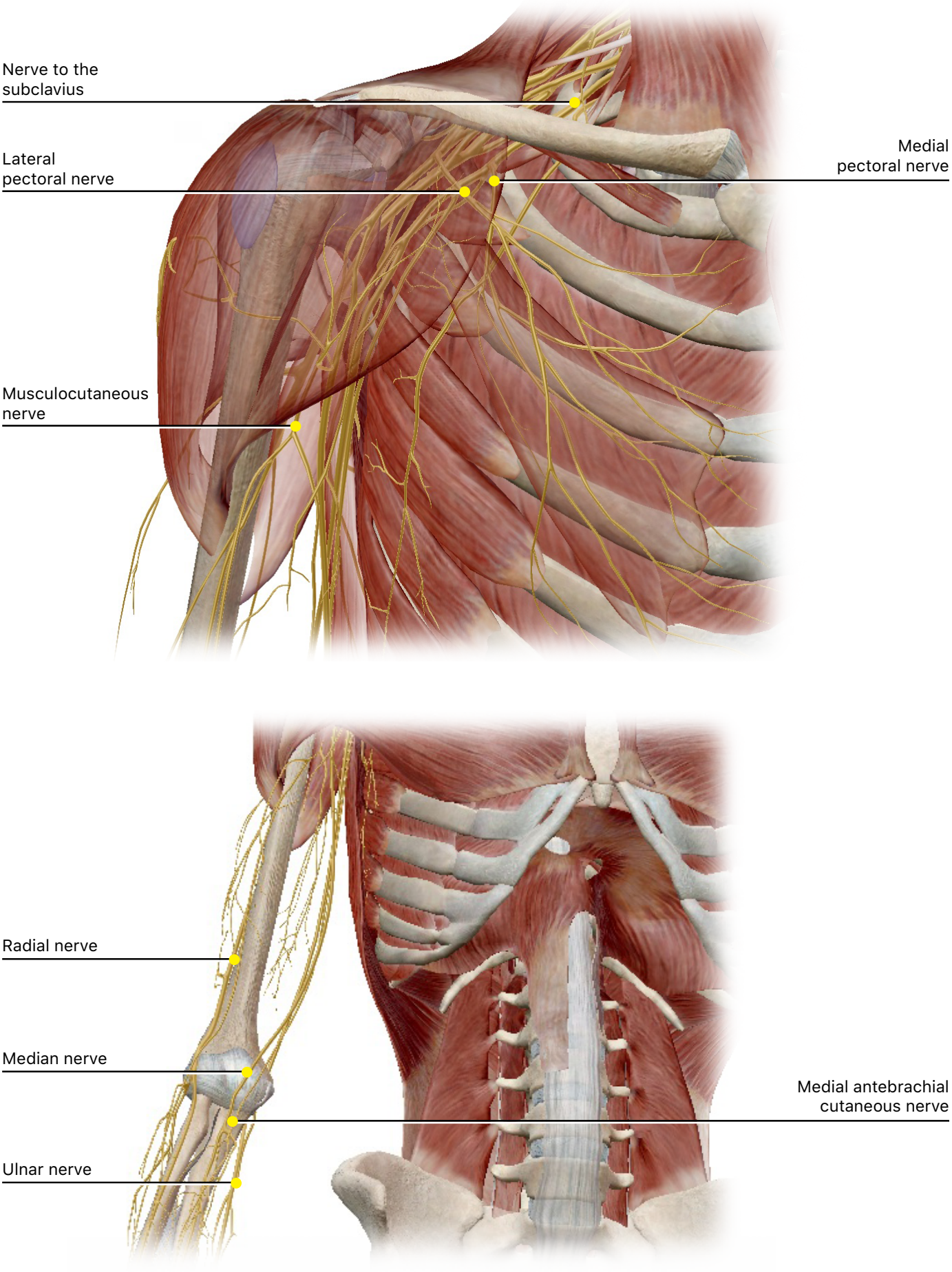
2. Select each cervical plexus nerve from the left-side menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

Nerve	**Origin**	**Innervations**
Transverse cervical	C02–C03	The skin of the anterior neck
Great auricular		
Lesser occipital		
Supraclavicular		
Phrenic		

F. Explore the 3D anatomical views in Modules 19.12 Brachial Plexus, 19.13 Brachial Innervation I, 19.14 Brachial Innervation II, and 19.15 Brachial Innervation III. Use these modules to answer the following questions.






Nerve to the subclavius
Lateral pectoral nerve
Musculocutaneous nerve
Medial pectoral nerve
Radial nerve
Median nerve
Ulnar nerve
Medial antebrachial cutaneous nerve

1. In Module 19.12 Brachial Plexus, select the **brachial plexus** from the left-side menu and use the book icon to read its definition.

a. The brachial plexus branches to supply the skin and muscles of the _____ and _____.

b. Brachial plexus nerves arise mostly from the _____ rami of spinal nerves _____, with a few from _____.

c. The upper part of the brachial plexus is divided into _____, _____ and _____.

2. Select **trunks** from the left-side menu to highlight them in the view and use the book icon to review the brachial plexus definition.

a. How many trunks are there on each side?

b. What are the names of these trunks?

3. Select the **divisions** from the left-side menu to highlight them in the view and use the book icon to review the brachial plexus definition.

a. The divisions arise from the _____ as they pass under the _____.

b. Each one splits into an _____ division and a _____ division.

4. Select the **cords** from the left-side menu to highlight them in the view and use the book icon to review the brachial plexus definition.

a. How many **cords** are there on each side?

b. The cords are named for _____.

c. Give the names of the cords and describe how they are formed.

d. The cords produce _____ and _____ branches that become the nerves in the _____ and the _____.

5. Use the right arrow at the bottom of the left-side menu to open Module 19.13 Brachial Innervation I and learn about the brachial plexus nerves that supply the **shoulder** and **upper back**. Select each nerve from the left-side menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

Nerves	Origin	Innervations
Dorsal scapular		
Suprascapular		
Subscapular		
Thoracodorsal		
Axillary		

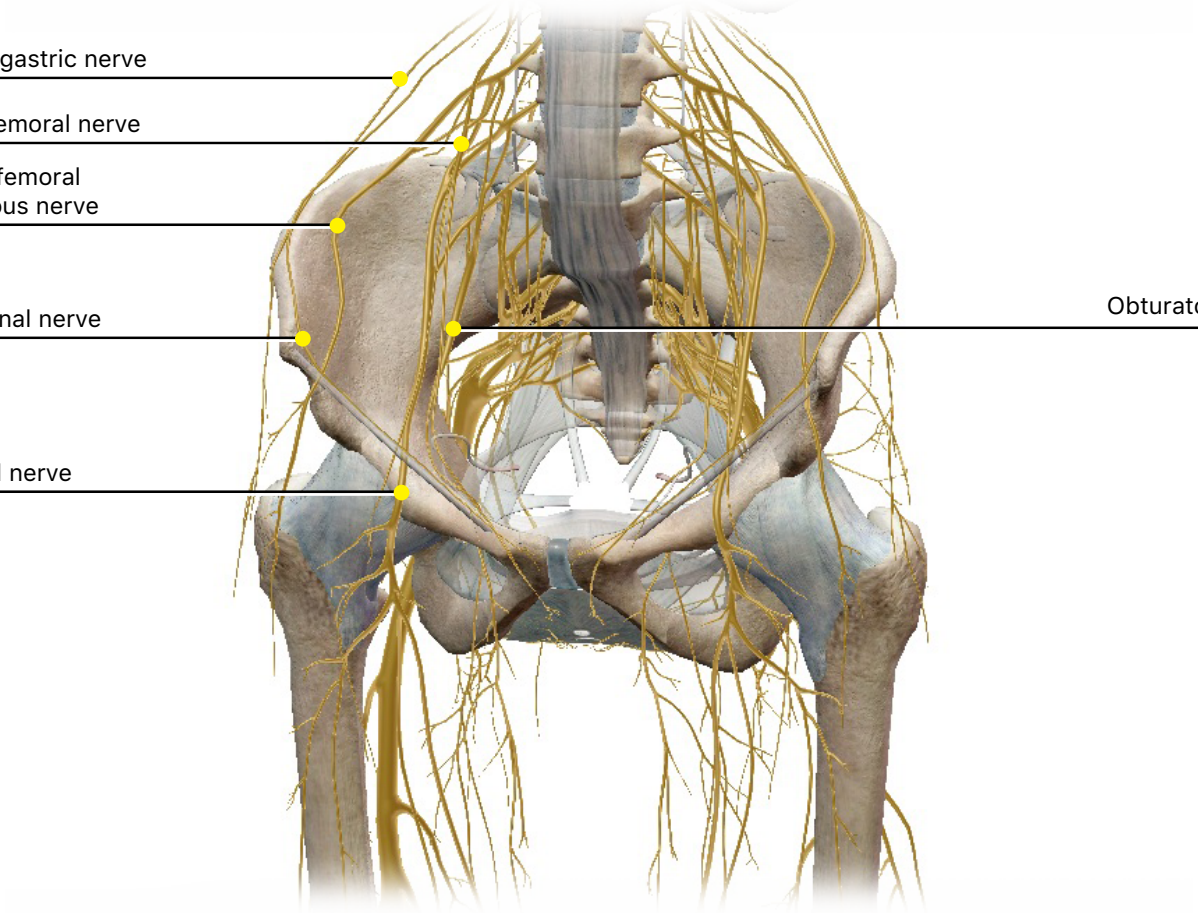
6. Use the right arrow at the bottom of the left-side menu to open Module 19.14 Brachial Innervation II and learn about the brachial plexus nerves that supply the **chest** and **arm**. Select each nerve from the left-side menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

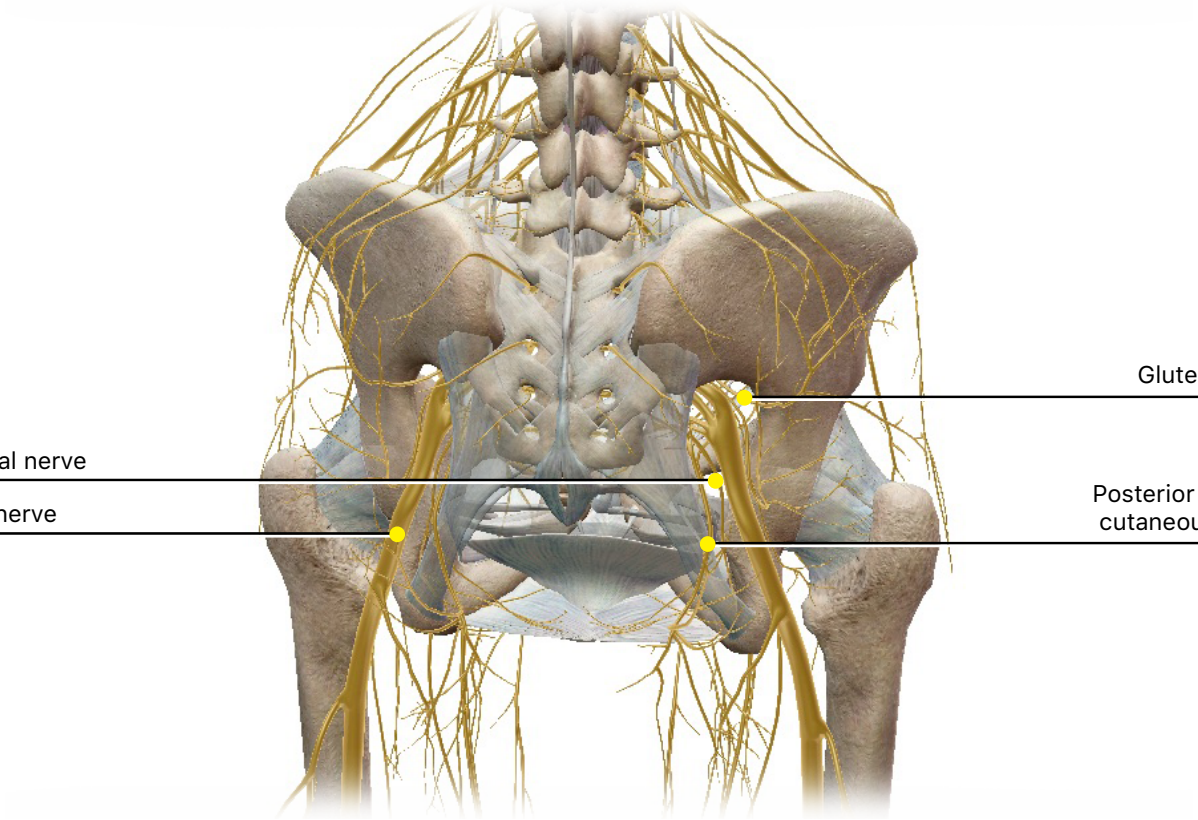
Nerves	Origin	Innervations
Medial pectoral		
Lateral pectoral		
Musculocutaneous		
Nerve to the subclavius		

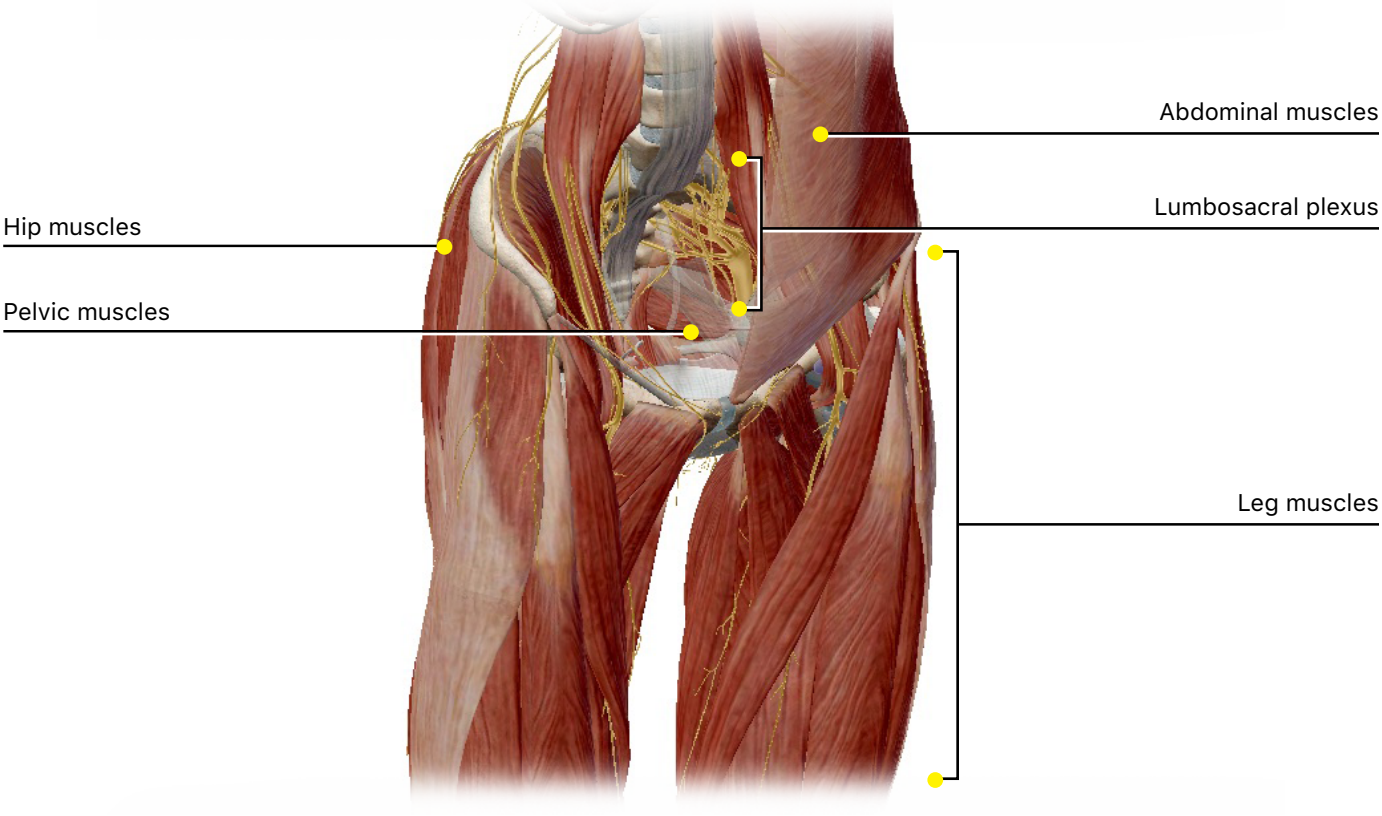
7. Use the right arrow at the bottom of the left-side menu to open Module 19.15 Brachial Innervation III and learn about the brachial plexus nerves that supply the **forearm** and **hand**. Select each nerve from the left-side menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

Nerves	Origin	Innervations
Median		
Radial		
Ulnar		
Median antebrachial cutaneous		

G. Explore the 3D anatomical views in Modules 19.16 Lumbosacral Plexus I, 19.17 Lumbosacral Plexus II, and 19.18 Lumbosacral Innervation. Use these modules to answer the following questions.







1. In Module 19.16 Lumbosacral Plexus I, select the **lumbosacral plexus** from the left side menu and use the book icon to read its definition.

a. Which body regions are supplied by the lumbosacral plexus?

b. The nerves of the lumbosacral plexus arise from the _____ rami and the _____ **segments** of spinal nerves _____.

c. The lumbosacral plexus can be functionally divided into the _____ and the _____.

d. The **lumbar plexus** nerves arise from spinal nerves _____.

e. Name the three major nerves of the lumbar plexus.

f. The **sacral plexus** nerves arise from spinal nerves _____.

g. Name the two major nerves of the sacral plexus.

2. Select each upper lumbosacral nerve from the left-hand menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

Nerves	Origin	Innervations
Iliohypogastric		
Ilioinguinal		
Genitofemoral		
Femoral		
Obturator		
Lateral femoral cutaneous		

3. Use the right arrow at the bottom of the left-side menu to open Module 19.17 Lumbosacral Plexus II. Select the **sciatic nerve** from the left-side menu and use the book icon to read a description of the sciatic nerve, which is the thickest and longest nerve in the body.

a. The sciatic nerve originates from spinal nerves _____.

b. The sciatic nerve directly innervates the _____ muscles and then branches at the _____ into the _____ and _____ nerves that innervate the muscles of the distal leg and foot.

4. Select each lower lumbosacral nerve from the left-side menu and use the book icon to read its definition. Then, complete the following table by noting the origin and innervations of each nerve.

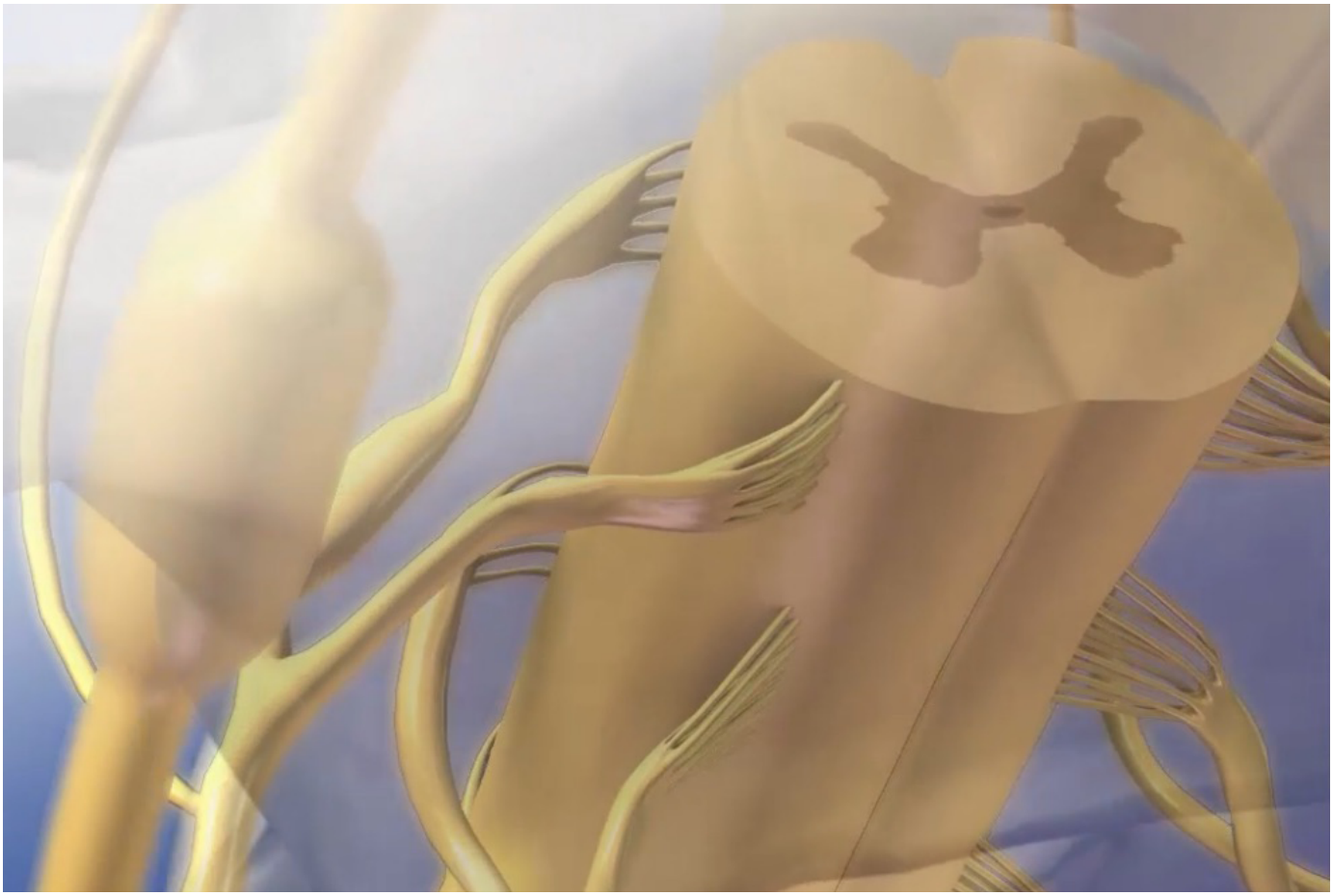
Nerves	Origin	Innervations
Gluteal		
Pudendal		
Posterior femoral cutaneous		
Posterior femoral cutaneous		
Fibular		

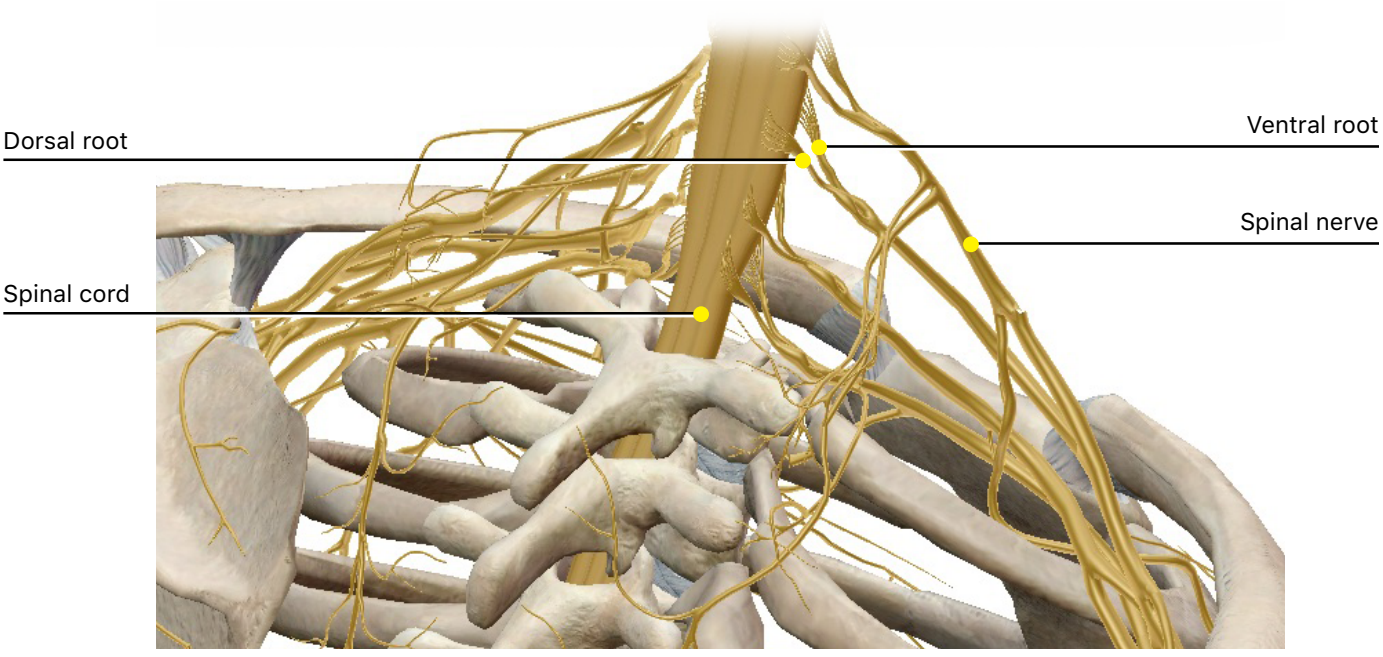
5. Use the right arrow at the bottom of the left-side menu to open Module 19.18 Lumbosacral Innervation. Select the lumbosacral plexus from the left-side menu and use the book icon to review its definition.

a. The lumbosacral plexus innervates many regions of the _____ and the muscles of the _____.

b. Select each muscle group in the left-side menu to observe the location of the abdominal muscles, hip and gluteal region muscles, pelvic muscles, and leg and foot muscles. Use the book icon to read a description of each muscle group.

H. Watch the video in Module 19.19 Involuntary Reflexes, explore the 3D anatomical view in Module 19.20 Path of Reflex Arc, and answer the following questions.





1. In Module 19.19 Involuntary Reflexes, watch the video and read the text to learn about how some somatic muscles, normally under voluntary control, can be recruited for an involuntary reflexive movement that protects the body. Somatic reflexes need to be fast. They occur before messages about the action reach the _____.

2. The route the reflex signals take is known as the _____. Signals are transmitted from the periphery to the _____, which then sends **motor signals** back out to muscles that respond quickly to protect the body.

a. The **reflex arc** begins when a _____ detects a dangerous stimulus.

b. The **afferent signal** reaches the gray matter of the spinal cord, where cell bodies of _____ interpret the signal.

c. If a response is required, it will be sent to an _____ neuron, and its axons will exit the spinal cord and stimulate the appropriate muscle.

3. Use the right arrow at the bottom of the left-side menu to open Module 19.20 Path of Reflex arc.

a. Select the spinal nerve from the left-side menu to highlight it in the view. Signals of a reflex arc pass from the _____ through afferent fibers of a spinal nerve.

b. Select the dorsal root from the left-side menu to highlight it in the view. Sensory input traveling through spinal nerves enters the spinal cord via the _____ root.

c. Select the spinal cord from the left-side menu to highlight it in the view. Signals are processed in the _____ matter of the spinal cord by association neurons.

d. Select the ventral root from the left-side menu to highlight it in the view. If a signal requires a response, it is passed to motor neurons that send motor signals through their axons out of the spinal cord through the _____ roots.

PUTTING IT ALL TOGETHER

1. The spinal cord is found inside the _____ foramina of _____ and _____ vertebrae.

2. A fluid called _____ flows through the center of the spinal column in the _____.

3._____ matter is found in the center of the spinal cord. It is made up of _____. It is divided into three _____ on either side.

4._____ matter is found on the outside of the spinal cord. It is made up of _____ and is organized into _____. Axons of the white matter carry information *either* up or down the spinal cord.

5. Fibers that bring sensory information from the periphery to the CNS are called _____ or _____ fibers. Fibers that carry information from the CNS to the periphery are called _____ or _____ fibers.

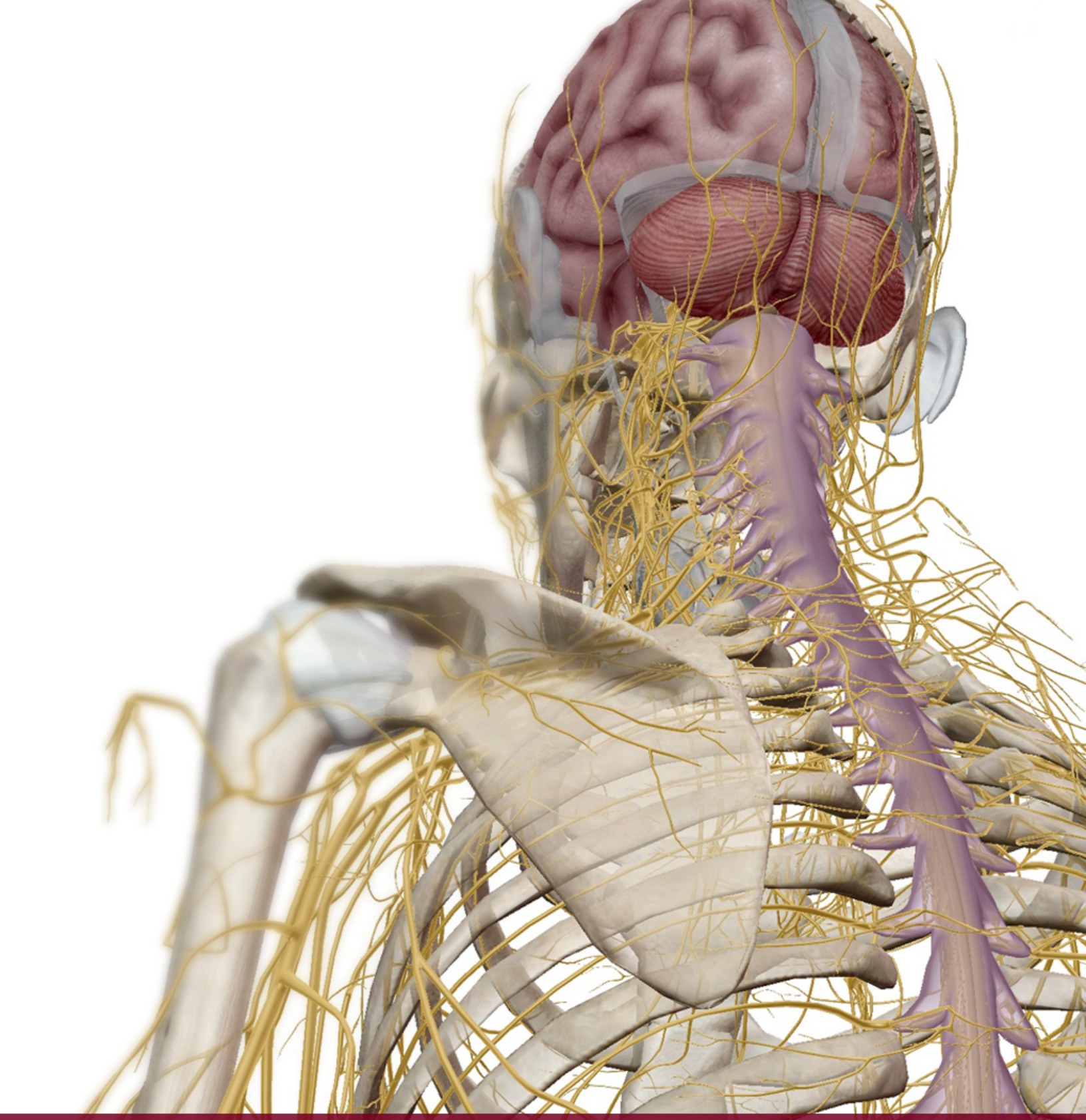
6. The peripheral nervous system mostly consists of the branches of the spinal nerves. Spinal nerves begin as (left and right) dorsal and ventral _____.

7. These roots join briefly to form _____ as they leave the vertebral column via the _____. Once these nerves leave the spinal column, they become part of the peripheral nervous system.

8. Soon after they leave the spinal column, spinal nerves branch into dorsal and ventral _____.

9. Branches of the spinal nerves form complex networks called _____. The three main ones are the _____.

10. When immediate action is required to protect the body, some skeletal muscles can be recruited by a spinal _____. These rapid movements are controlled by a series of cell connections called a _____. Sensory information sent from _____travels via sensory axons into the gray matter of the spinal cord, where _____ process (integrate) them. These cells pass the signal on to _____, which in turn stimulate muscles to contract without any input from the brain.

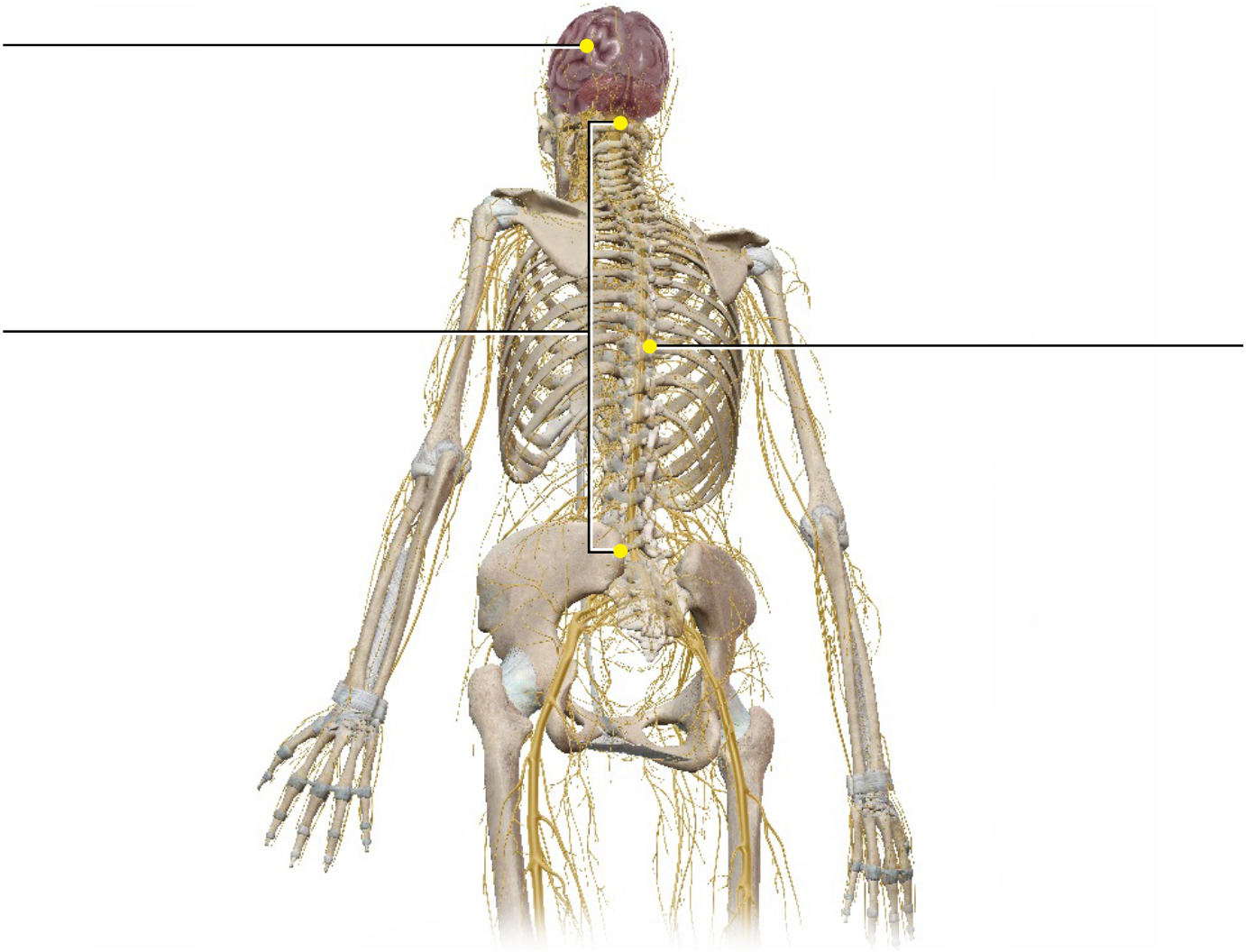


VISIBLE BODY®

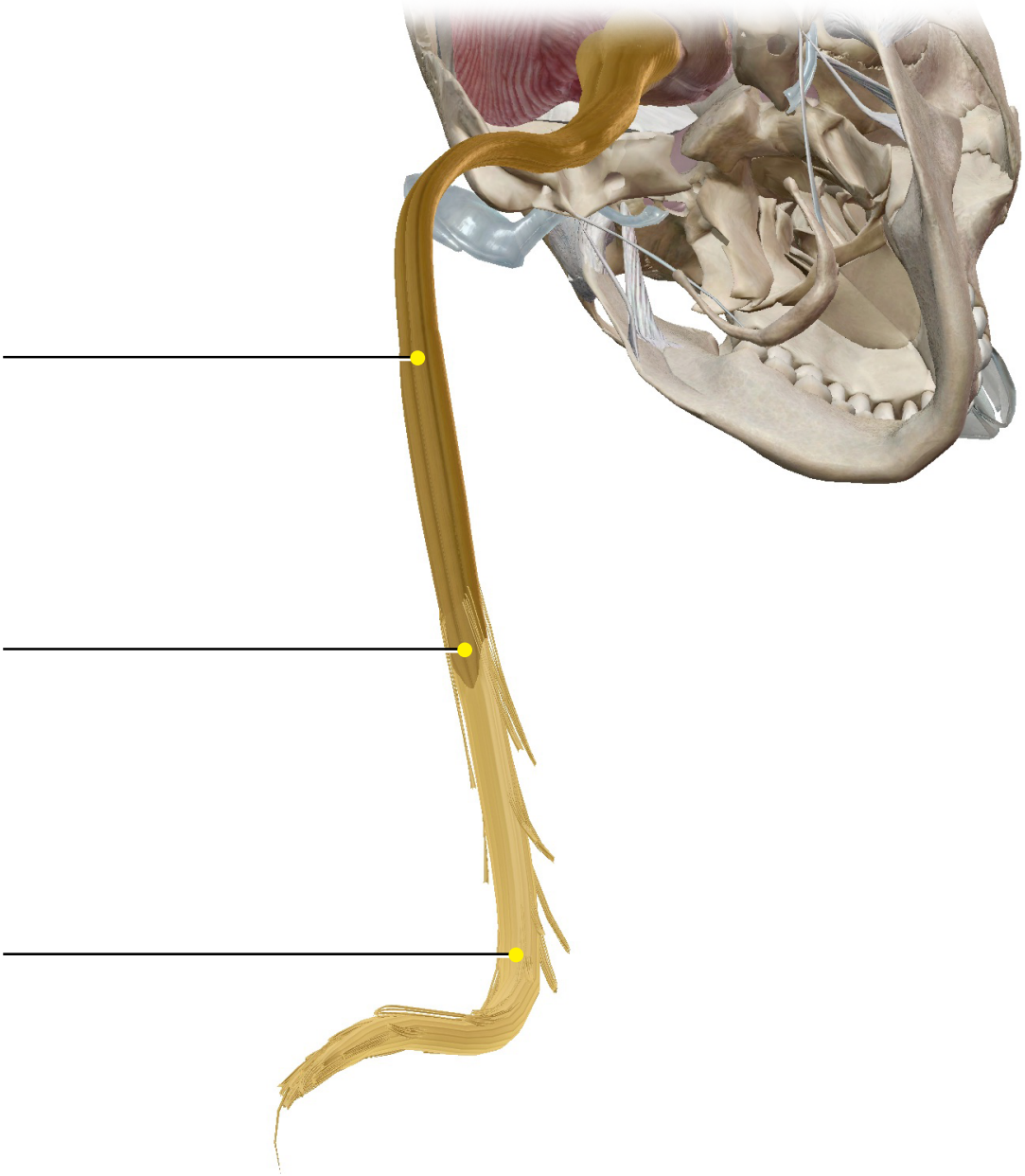
Student Practice

Label the structures in the following figures.

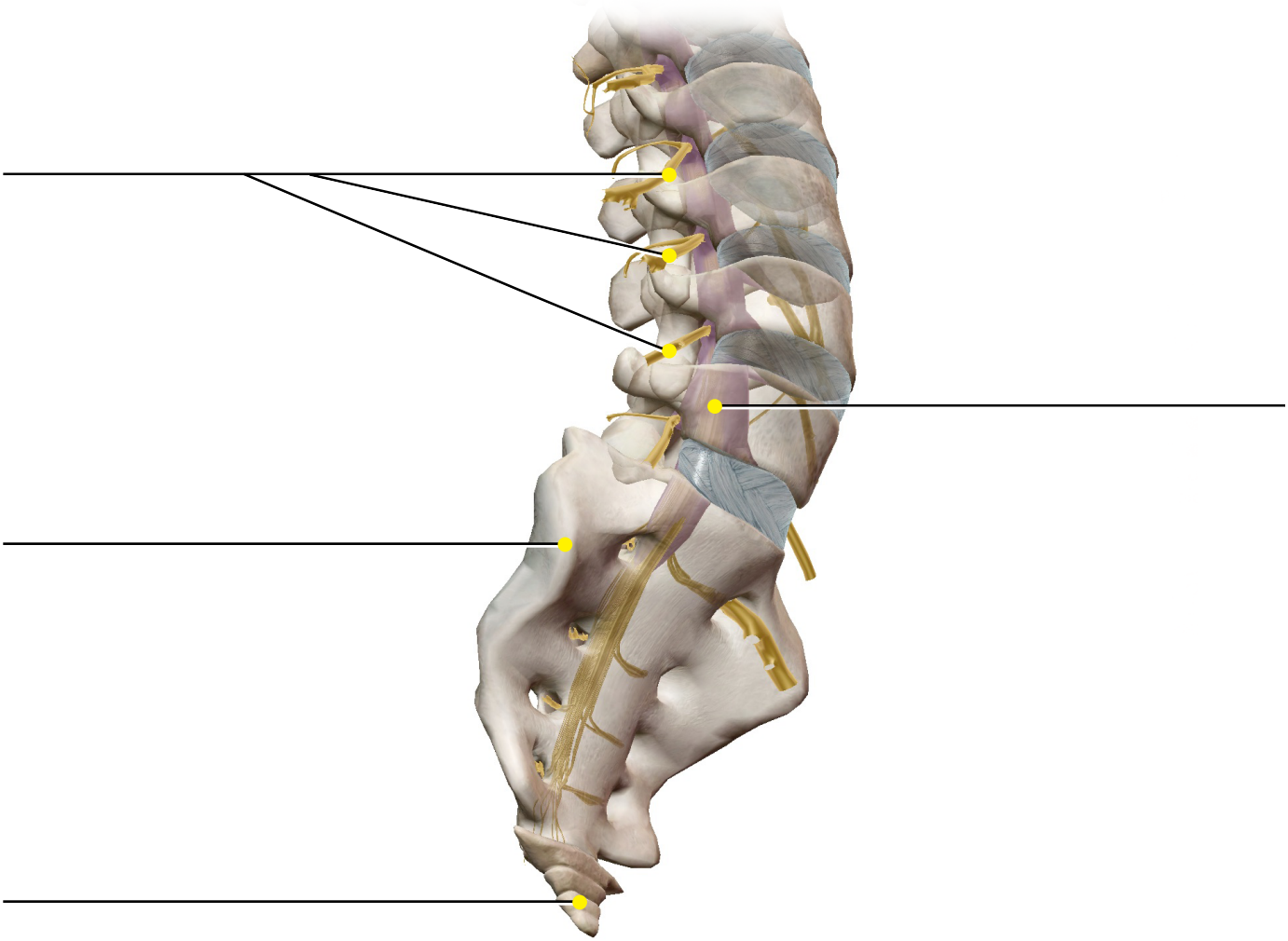
Module 17.3 Central Nervous System



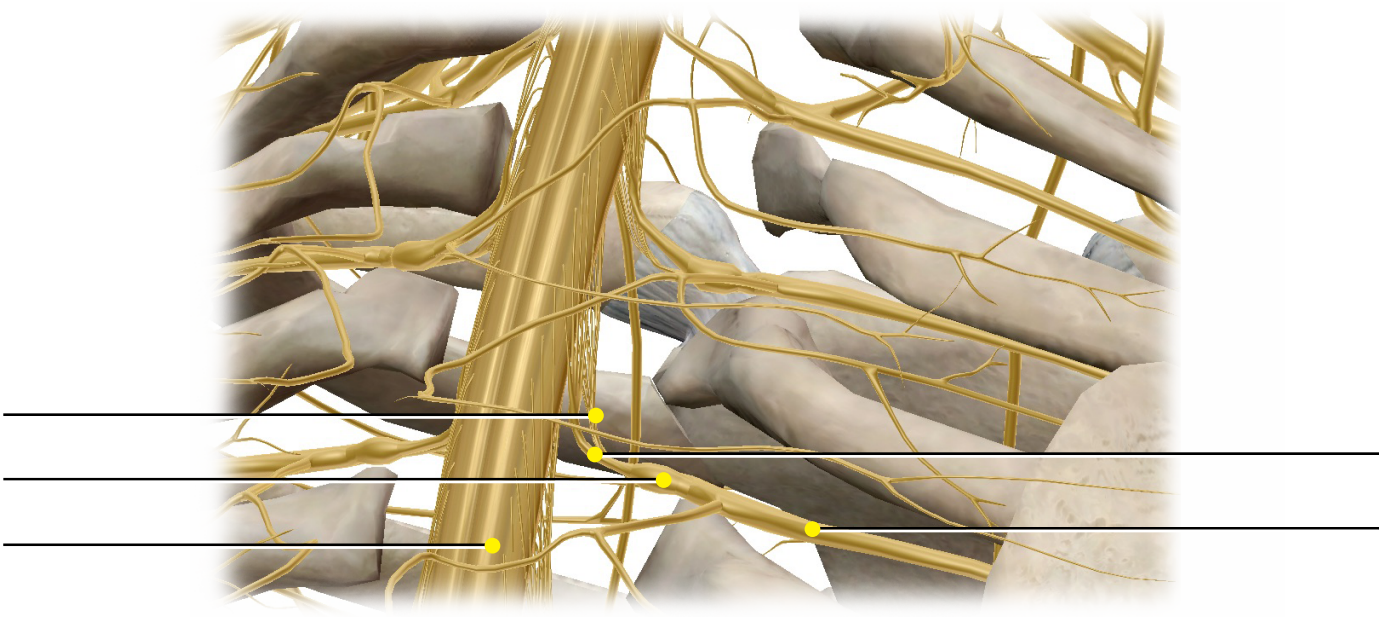
Module 19.1 Spinal Cord (Part 1)



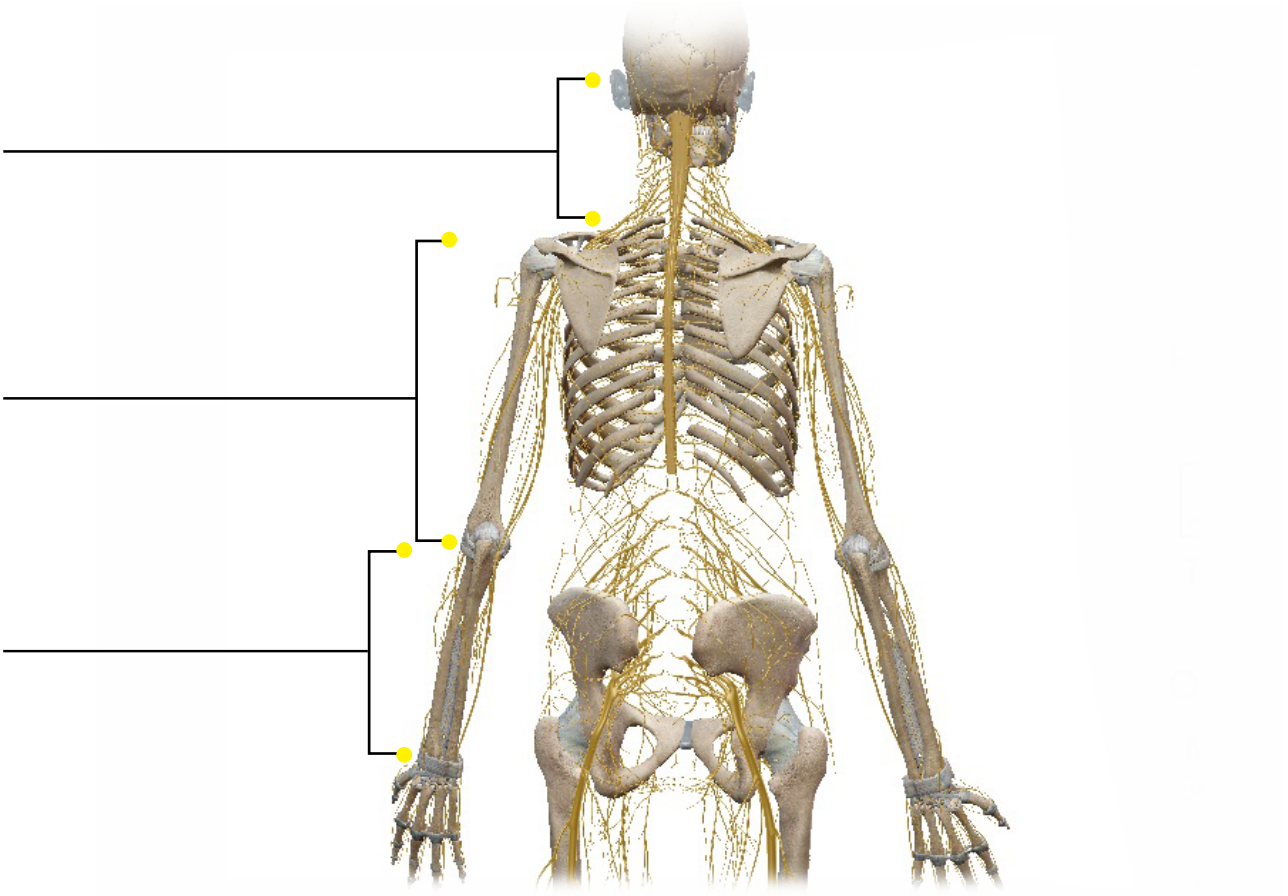
Module 19.1 Spinal Cord (Part 2)



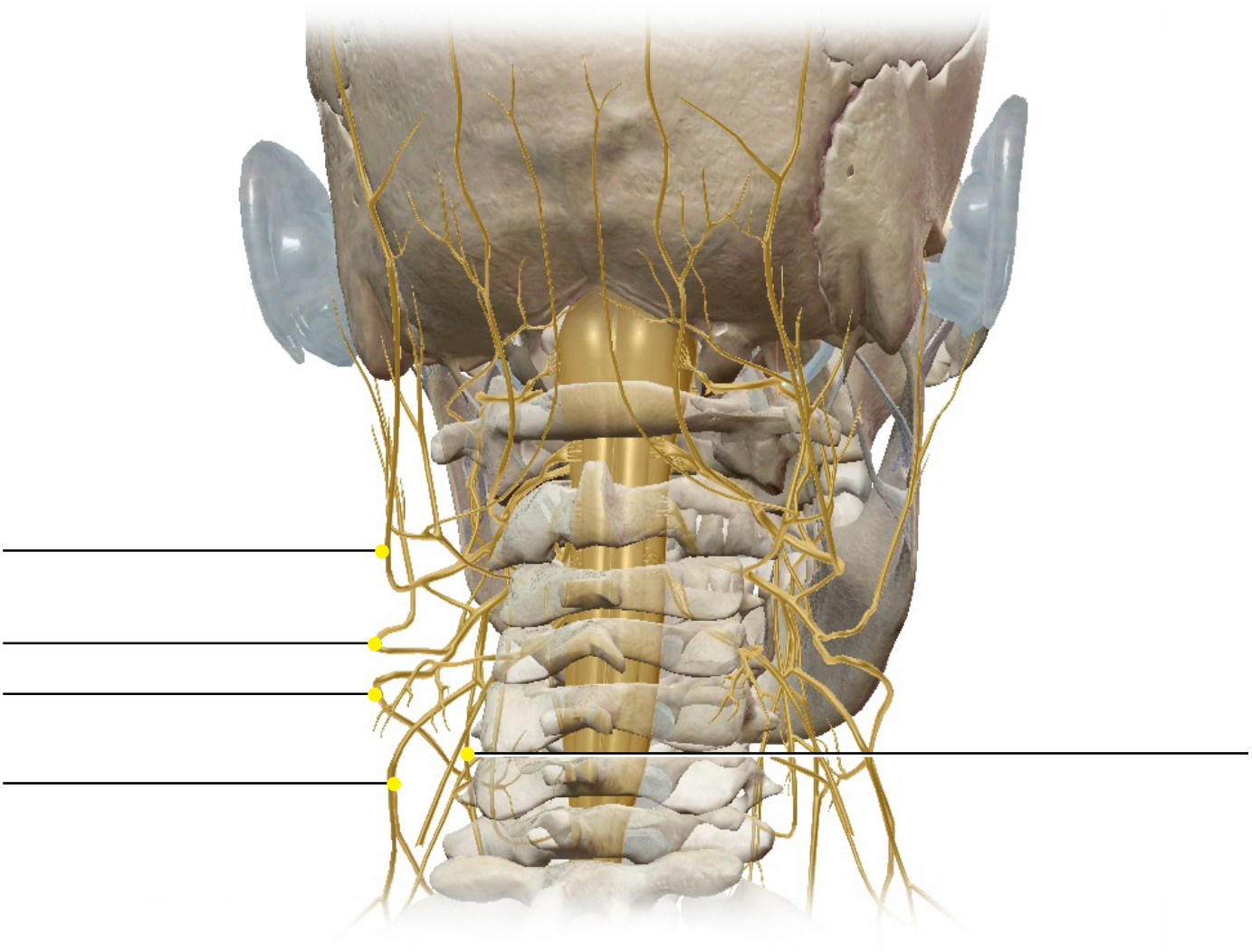
Module 19.3 Spinal Nerve Roots



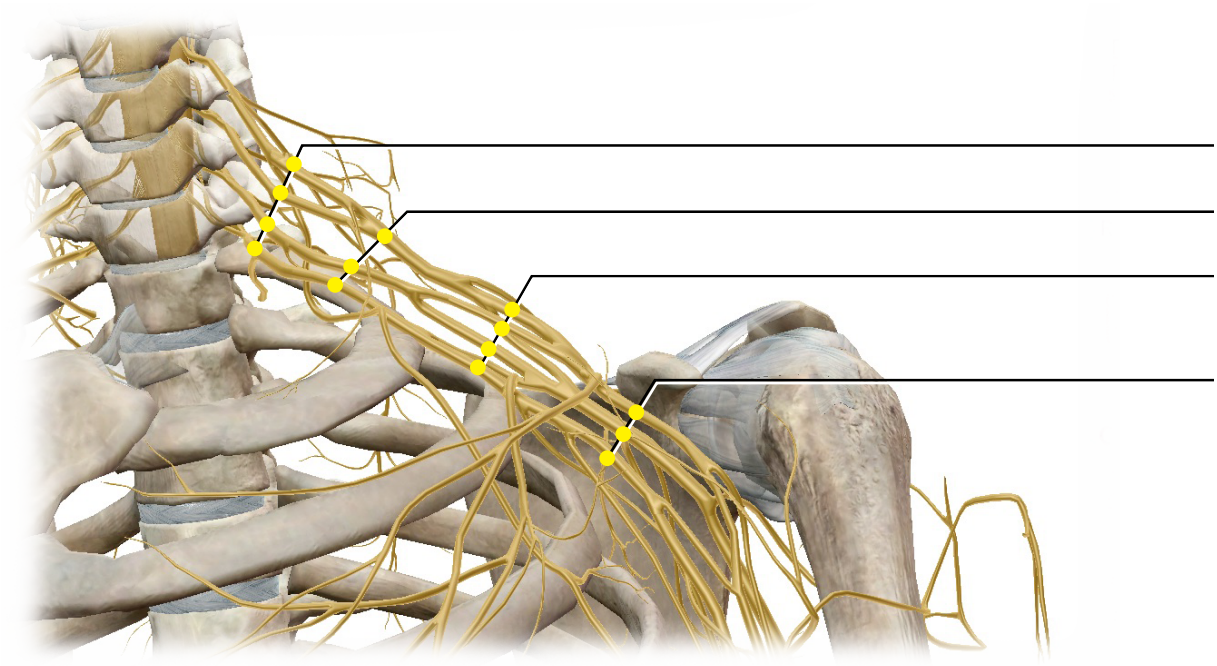
Module 19.8 Spinal Nerve Regions



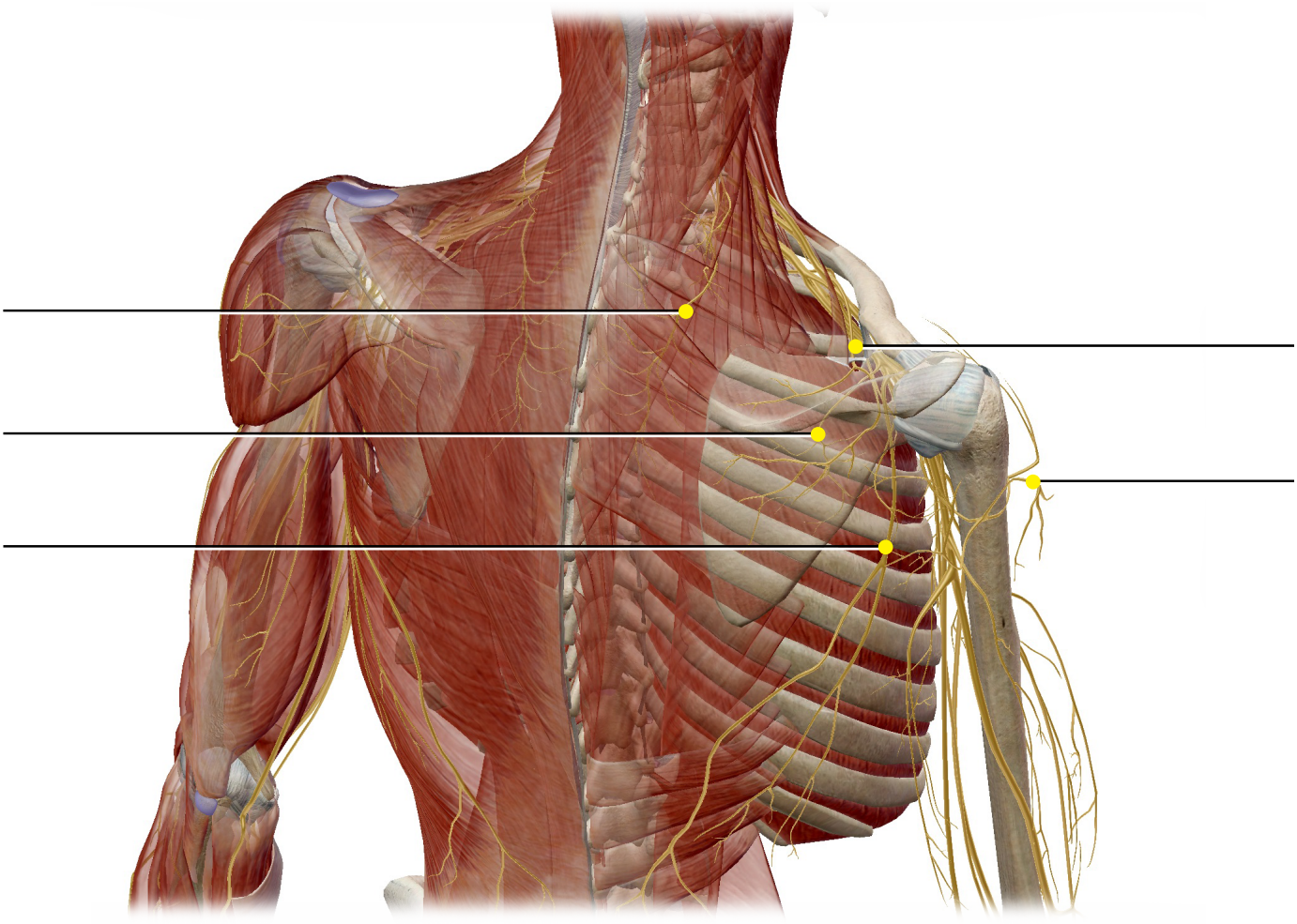
Module 19.10 Cervical Plexus



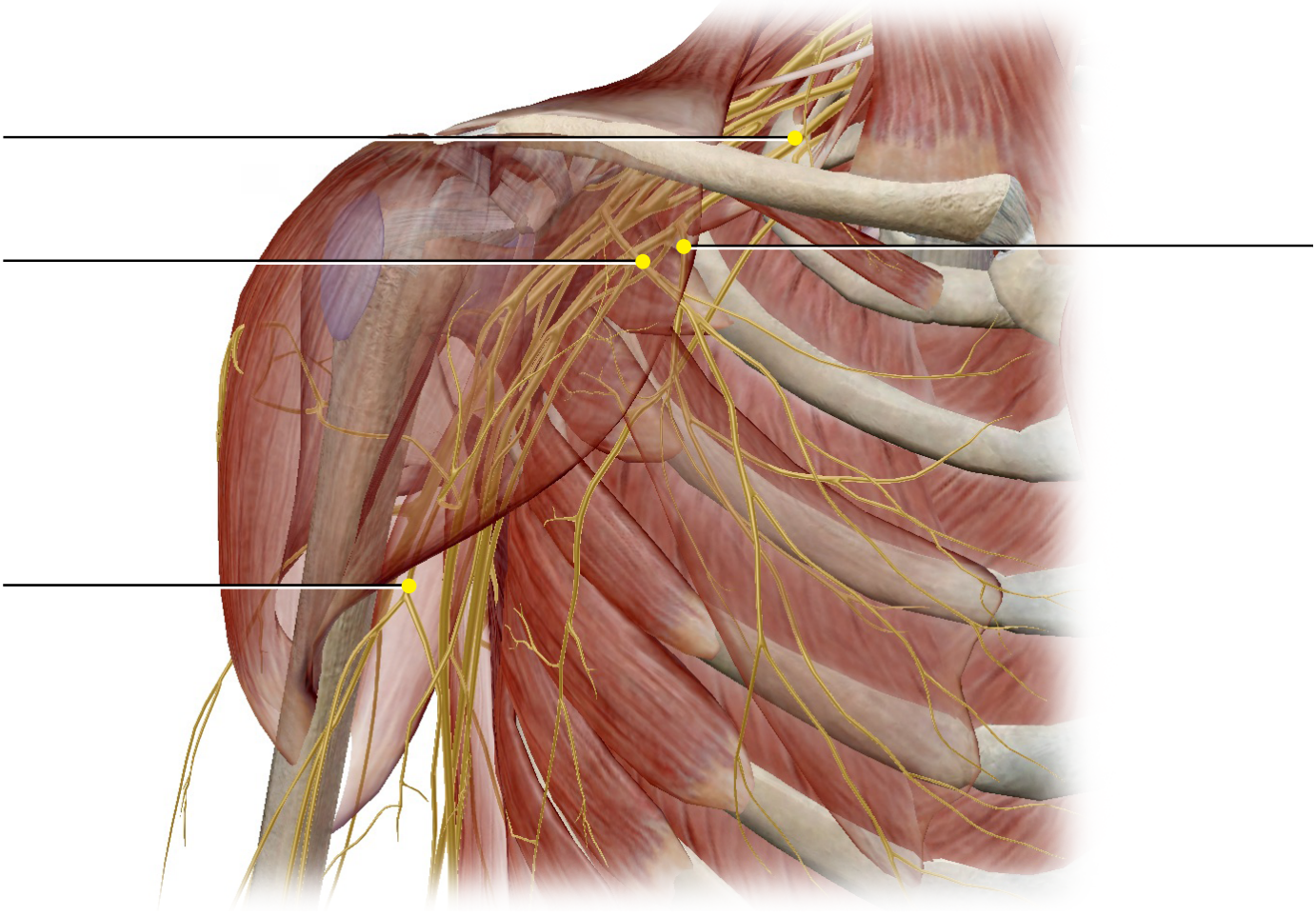
Module 19.12 Brachial Plexus



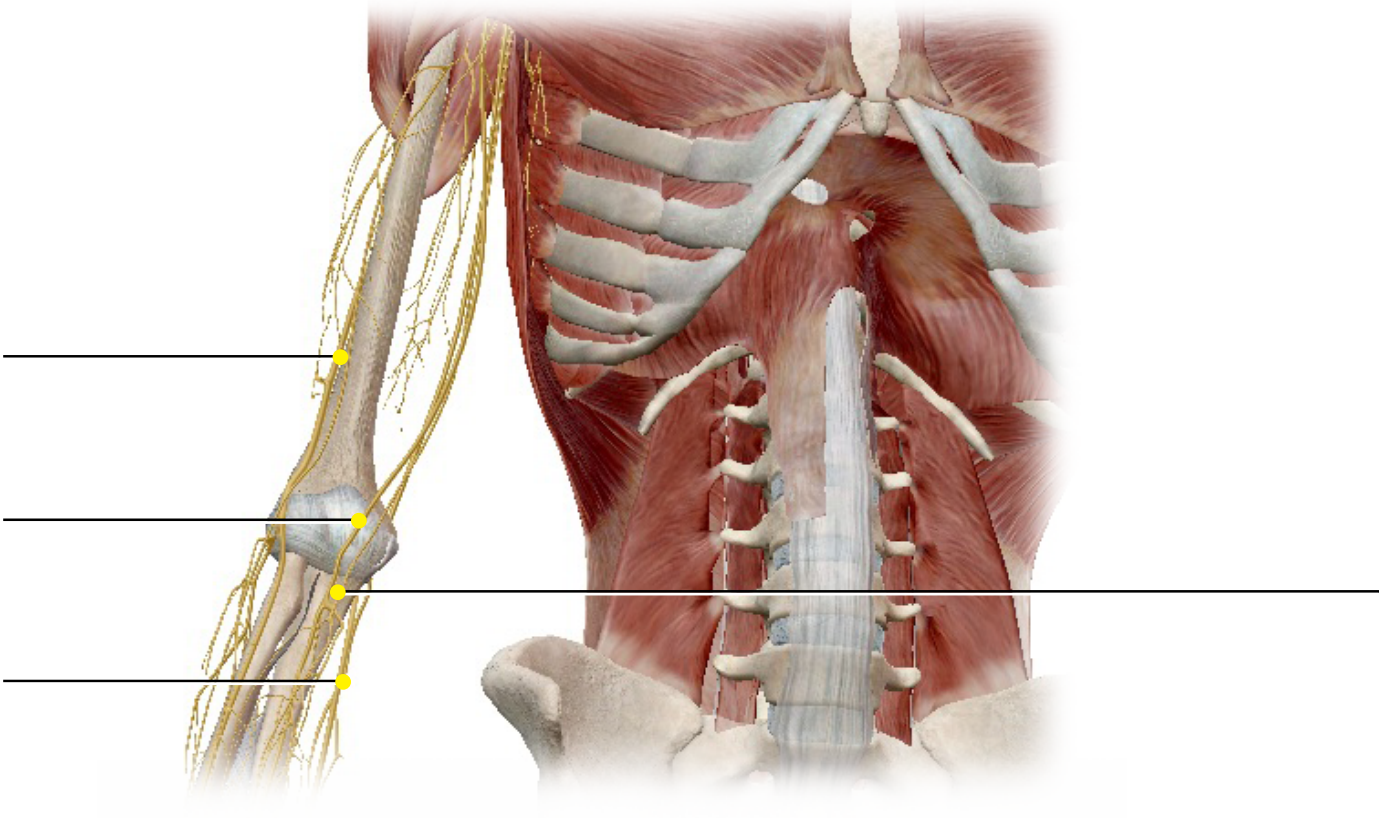
Module 19.13 Brachial Innervation I



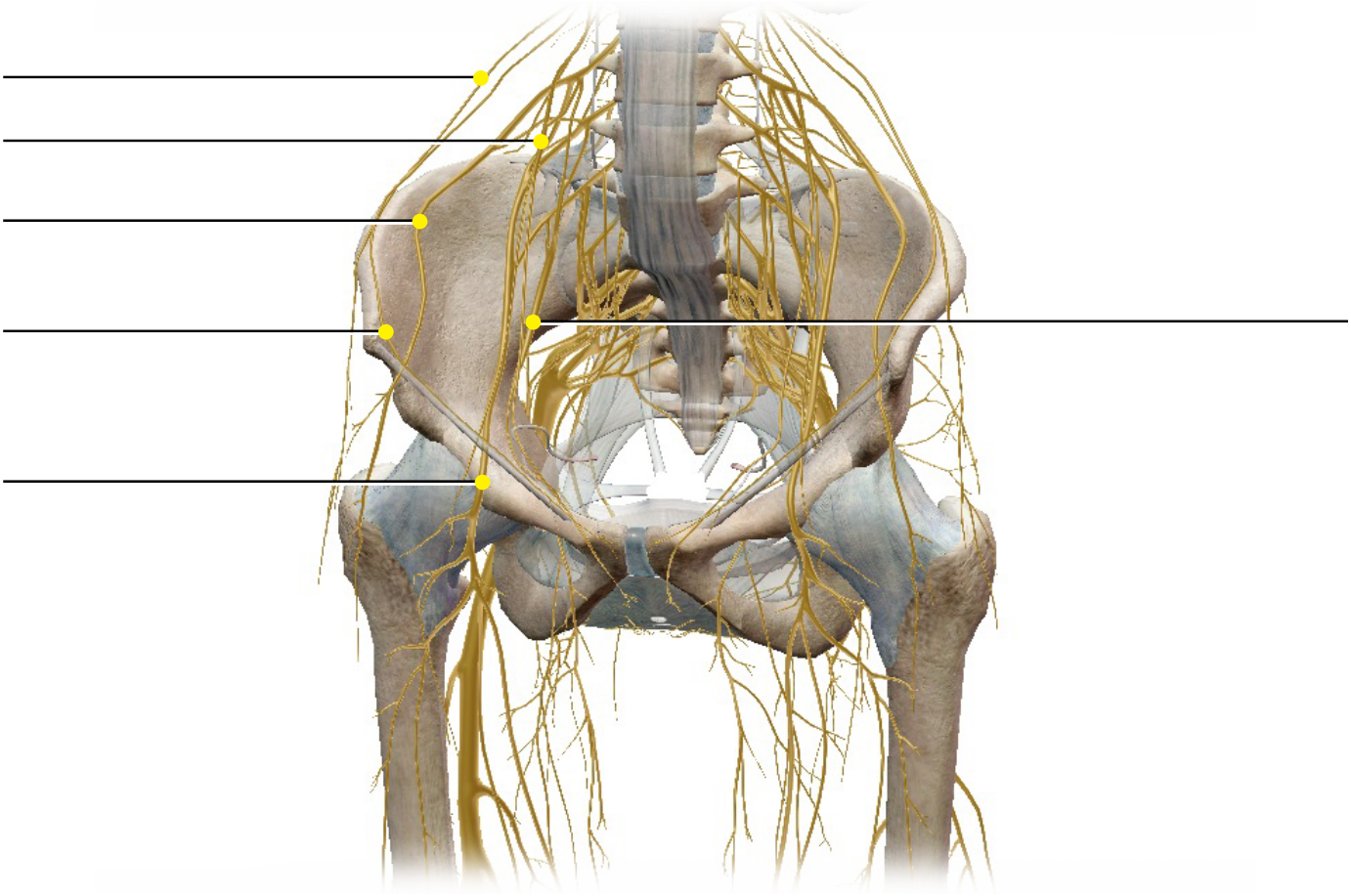
Module 19.14 Brachial Innervation II



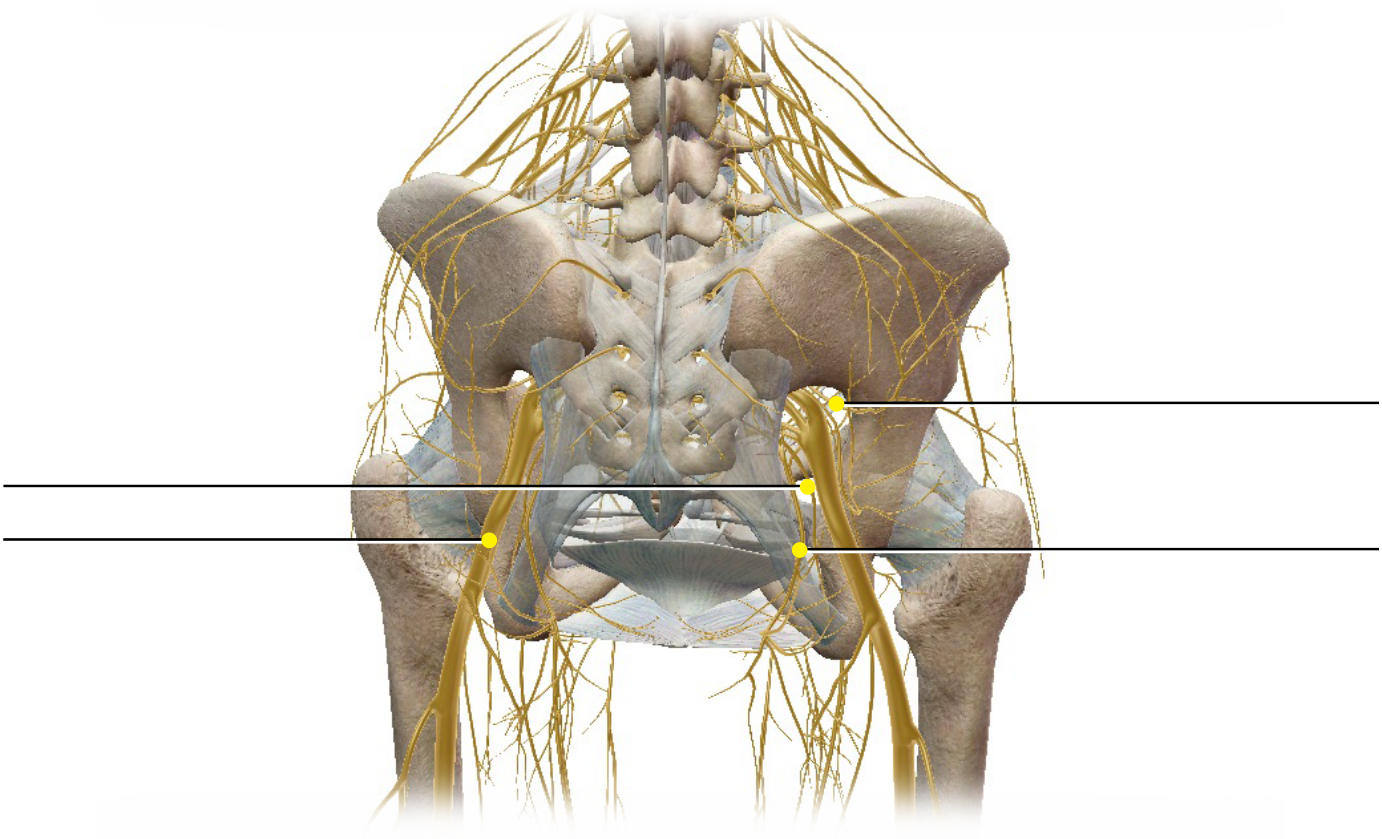
Module 19.15 Brachial Innervation III



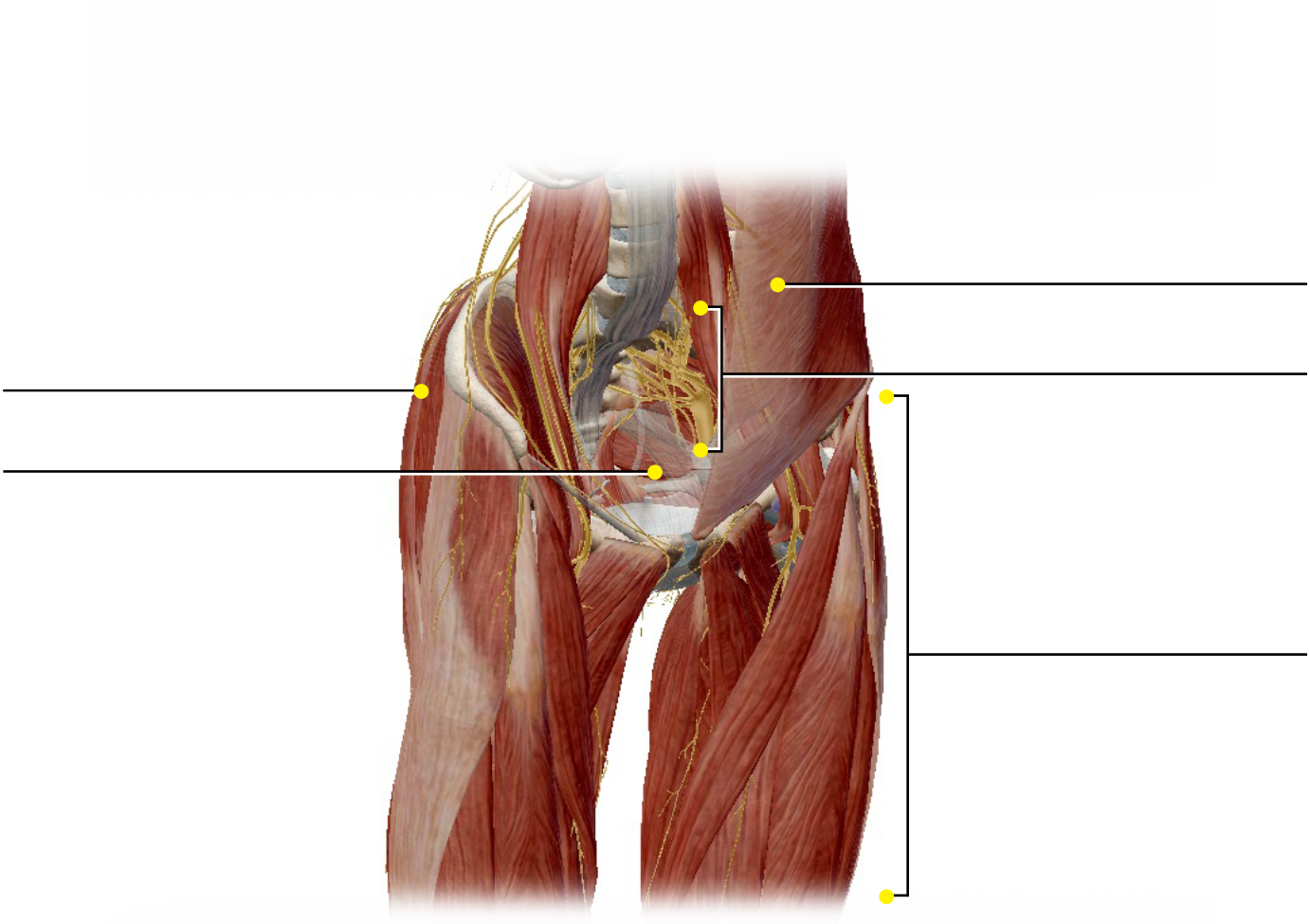
Module 19.16 Lumbosacral Plexus I



Module 19.17 Lumbosacral Plexus II



Module 19.18 Lumbosacral Innervation



Module 19.20 Path of Reflex Arc