1. The part of a spinal nerve that supplies the true back muscles and the skin overlying them is the:
   A) dorsal primary ramus
   B) dorsal root
   C) ventral primary ramus
   D) ventral root

2. Which is a source of axons found in the dorsal primary ramus of the 4th thoracic spinal nerve?
   A) Afferent neurons arising from the skin overlying the trapezius muscle
   B) Somatic motor neurons supplying the levator scapulae muscle
   C) Somatic motor neurons supplying the rhomboid muscles
   D) Somatic motor neurons supplying the trapezius muscle

3. A football player suffers a herniated (ruptured) intervertebral disk in his neck. The disk compresses the spinal nerve exiting through the intervertebral foramen between the 5th and 6th cervical vertebrae. Which spinal nerve is affected?
   A) C 4
   B) C 5
   C) C 6
   D) C 7
   E) C 8

4. A man has a herniated intervertebral disk between the fourth and fifth lumbar vertebrae. If this disk compresses the spinal nerve in the intervertebral foramen immediately posterior to this disk, which spinal nerve would be affected?
   A) L 3
   B) L 4
   C) L 5
5. Kyphosis is an accentuated or abnormal curvature of which region of the spine?
   A) cervical
   B) thoracic
   C) lumbar
   D) sacral
   E) coccygeal

6. Both the dural sac and the subarachnoid space end at which vertebral level?
   A) L 4
   B) L 5
   C) S 2
   D) S 1
   E) S 4

7. It is decided to image the spinal cord and spinal nerve rootlets by doing a myelogram (injection of a radio-opaque dye into the subarachnoid space followed by a radiograph). In order to inject the dye without injury to the spinal cord, the injection is usually done below what vertebral level?
   A) L 1
   B) L 2
   C) L 3
   D) L 4
   E) L 5

8. The myelogram revealed that the dye had leaked out along the spinal nerves in the mid cervical region on the right side. For the dye to leak out, what layer must have been torn or ruptured?
9. The myelogram also revealed that the dorsal and ventral rootlets of the 5th and 6th cervical nerves had been avulsed (torn or pulled out) from the spinal cord on the right side. Which nerve fibers would not be damaged by the avulsion?

A. general somatic afferent  
B. general somatic efferent  
C. preganglionic sympathetic  
D. postganglionic sympathetic

10. It was noted that after the injury the patient's face on the right side was flushed due to dilation of the blood vessels. The lack of vasoconstriction was due to interruption of what fibers somewhere along their course?

A. somatic afferent  
B. somatic efferent  
C. parasympathetic  
D. sympathetic

11. The intervertebral disk

A. is found between all adjacent vertebrae 
B. adds about 1/4th to entire length of vertebral column  
C. is a type of synovial joint within the vertebral column  
D. contains a compressible liquid center  
E. is perforated by the needle when performing a spinal tap
12. The conus medullaris:
A. exhibits both a cervical and lumbar enlargement
B. has a modification of neural tissue extending from its termination to the coccygeal ligament
C. gives origin to most of the cauda equina
D. is found at its lowest extent at S2
E. is normally anesthetized to perform a spinal tap

13. A neuron with a cell body in the dorsal root ganglia could convey what type of fibers?
A. motor to the deep back muscles
B. motor to the pectoralis major muscle
C. sensory from the skin overlying the trapezius
D. sympathetic preganglionics to the suprarenal medulla
E. visceral efferents to the stomach

14. The denticulate ligament:
A. is a modification of pia mater
B. is found between all dorsal and ventral roots
C. attaches to the dural sac continuously
D. has its terminal attachment at S2
E. holds the radicular arteries in place

15. A patient is suspected of having bacterial meningitis. As part of the diagnostic procedure, a lumbar puncture is to be performed. The attending physician asks you where she should insert the spinal needle to withdraw CSF. You answer, "just below the spine of the 4th lumbar vertebra." What reference point would you use to identify the spine?
A. Crest of the ilium
B. Ischial tuberosity
C. Pubic symphysis
Dumbilicus
Xiphoid process

16. As the spinal needle in the above question is being inserted, which ligament would it pass through on its way to the subarachnoid space?
A Anterior longitudinal
B Denticulate
C Ligamentum nuchae
D Posterior longitudinal
E Supraspinous

17. Because of their structure and interconnections, which veins are especially important in the metastatic spread of cancer?
A Basilic
B Cephalic
C Dorsal scapular
D Internal vertebral venous plexus
E Transverse cervical

18. The number of vertebrae and number of spinal cord segments are the same in each region except:
A Cervical
B Thoracic
C Lumbar
D Sacral

19. The subtrapezial plexus of nerves includes:
A C3, C4 and the dorsal scapular nerve
B C3, C4 and the accessory nerve
C C3, C4 and nerve to levator scapulae
Accessory and dorsal scapular nerves

Accessory nerve and nerve to levator scapulae

20. If in the process of doing a lumbar puncture a spinal needle was inserted posteriorly in the midline until it had just penetrated the posterior longitudinal ligament, would the needle have entered the subarachnoid space?

A Yes
B No

21. While moving into a new apartment a student lifting a heavy box of books experiences a sharp pain in his back, radiating down the anterior thigh and medial side of his leg. After several days of misery, he finally goes for treatment and is told that he has a herniated intervertebral disk at the L 4 level which is compressing a spinal nerve where it exits the vertebral column. The point of compression is the:

A Central canal
B Foramen magnum
C Hiatus of the sacral canal
D Intervertebral foramen
E Vertebral foramen

22. Which muscle is innervated by posterior primary rami?

A Latissimus dorsi
B Levator scapulae
C Rhomboideus major
D Erector spinae
E Trapezius

23. The spinal cord is segmented like the vertebral column, but in contrast to the vertebrae, there are only _____ cord segments

A 28
B 29
24. A patient is suspected of having bacterial meningitis. A lumbar puncture is performed to remove cerebrospinal fluid (CSF) for analysis. If done properly, the needle used for the tap would penetrate all layers except:

A. Arachnoid mater  
B. Epidural fat  
C. Dura mater  
D. Pia mater  
E. Supraspinous ligament

25. Quasimoto, the "Hunchback of Notre Dame," suffered from an abnormal thoracic curvature called kyphosis. In this condition the accentuated convexity of the curvature is:

A. Anterior  
B. Caudal  
C. Lateral  
D. Medial  
E. Posterior

26. A patient is suspected of having bacterial meningitis. A lumbar puncture is performed to remove cerebrospinal fluid (CSF) for analysis. The fluid would be removed from the:

A. Epidural space at the level of L3  
B. Intervertebral foramen at the level of L2  
C. Spinal canal at level of L3  
D. Subdural space at the level of L4  
E. Subarachnoid space at the level of L4
27. A 60-year-old male presented with a number of unusual signs and symptoms in the facial region. Among others, it was found that the right side of his face was flushed (red). Further testing revealed a lack of ability to sweat in the same cutaneous region. Which nervous structures were most likely implicated in this set of clinical abnormalities?

A. Cranial outflow of the ANS  
B. Dorsal roots of cervical nerves  
C. Gray rami communicantes of T5  
D. Sympathetic nerve fibers  
E. Vagus nerves

28. In the lumbar spine, the L4 nerve root sleeve exits:

A. above the pedicle of L4 and at the top of the intervertebral foramen  
B. above the pedicle of L4 and at the bottom of the intervertebral foramen  
C. below the pedicle of L4 and at the top of the intervertebral foramen  
D. below the pedicle of L4 and at the bottom of the intervertebral foramen

29. Which structure does NOT contain efferent autonomic nerve fibers?

A. Dorsal ramus of C4  
B. Dorsal root of T6  
C. Ventral root of T3  
D. Ventral ramus of L2

30. In order to expose the spinal cord from the posterior side, it is necessary to remove the:

A. Laminae, pedicles and ligamenta flavum  
B. Laminae, spinous processes and ligamenta flavum
31. In an adult, the conus medullaris of the spinal cord is normally positioned at which vertebral body levels:

A. T10-T12
B. T12-L2
C. L2-L4
D. L5-S1

32. Inserting a spinal tap needle in the lumbar region, in the midline, you hear and feel a 'pop' at the needle tip. What structure was perforated to cause the 'pop?'

A. intervertebral disk
B. anterior longitudinal ligament
C. ligamentum flavum
D. dura mater
E. arachnoid mater

33. Prostate cancer is diagnosed in an 82 year old male. Thereafter a malignant brain tumor of prostatic origin is found. He subsequently dies. An autopsy reveals tumor sites in the prostate, vertebral column, and brain, but no other organs. By what vascular pathway did the cancerous cells get to the brain:

A. anterior spinal artery
B. vertebral venous plexus
C. azygos venous system
D. vertebral artery
E. thoracic duct

34. Which of the following statements about the artery of Adamkiewicz is not correct?

A. It is also known as the artery of the lumbar enlargement
It is a radicular (or radiculomedullary) artery in the lower thoracic or upper lumbar region

It is most frequently found on the left side

It has extensive collateralization (anastomoses) on the surface of the thoracic spinal cord

It passes along the surface of a ventral root of a spinal nerve to reach the cord

35. A 45-year-old man complained to his physician that the muscles of his upper limb were weak and he felt clumsy while walking. Tests revealed that he had amyotrophic lateral sclerosis (Lou Gehrig’s disease), a disease which attacks the neurons of the voluntary motor system. Where would one expect to see atrophic or degenerated nerve cell bodies?

A. Dorsal horn of the spinal cord
B. Dorsal root ganglion
C. Lateral horn of the spinal cord
D. Sympathetic chain ganglia
E. Ventral horn of the spinal cord

36. A patient is diagnosed as having a venous anomaly of the posterior spinal veins which have enlarged, putting pressure on the spinal cord. In order to expose the veins, the surgeon will have to pass through the skin, subcutaneous tissue, deep back muscles and then, in order, the:

A. Laminae and ligamenta flava, posterior longitudinal ligament, epidural space, dura, subdural space, arachnoid, subarachnoid space, pia
B. Pedicles and ligamenta flava, epidural space, dura, subdural space, arachnoid, subarachnoid space, pia.
C. Laminae and ligamenta flava, epidural space, dura, subdural space, arachnoid, subarachnoid space, pia.
D. Pedicles, posterior longitudinal ligament, epidural space, dura,
subdural space, arachnoid, subarachnoid space, pia.

Laminae and ligamenta flava, epidural space, pia.

37. A University student comes to the Emergency Room with a high fever, lethargy and a stiff neck. After further examination, meningitis is suspected and a lumbar puncture is ordered. What landmark could be used to insert the spinal needle between the 4th and 5th lumbar vertebral spines?

A. Anterior superior iliac spine
B. Costal margin
C. Iliac crest
D. Transpyloric plane
E. Umbilicus

38. If one does a laminectomy (removing the laminae of two adjacent vertebrae) to expose the spinal cord, which ligament must be removed?

A. anterior longitudinal
B. denticulate
C. ligamentum flavum
D. ligamentum nuchae
E. posterior longitudinal

39. In the final stages of labor a caudal anesthetic is sometimes given via a needle inserted into the sacral hiatus. The anesthetic is thus placed around the outside of the sacral spinal nerve roots and into the:

A. Central canal
B. Dural sinus
C. Epidural space
D. Subarachnoid space
E. Subdural space
1. The correct answer is: **dorsal primary ramus**

The dorsal primary ramus supplies sensory innervation to the skin of the back and motor innervation to the true back muscles. Ventral primary rami supply sensory innervation to the skin of the anterior trunk and limbs and motor innervation to the skeletal muscles of the neck, trunk, and extremities. The ventral and dorsal roots of a spinal nerve are made of the ventral and dorsal rootlets, which come from the spinal cord. The ventral root contains efferent motor fibers, while the dorsal root contains afferent sensory fibers. The two roots eventually fuse to form a spinal nerve which gives off the dorsal and ventral primary rami.

2. The correct answer is: **Afferent neurons arising from the skin overlying the trapezius muscle**

Dorsal primary rami innervate the true back muscles (like erector spinae) and the skin overlying the back. So, they would contain afferent neurons arising from the skin overlying the trapezius muscle. The rhomboid muscles and levator scapulae are not true back muscles. This means that they are innervated by the ventral primary rami of spinal nerves, not the dorsal primary rami. The trapezius receives motor innervation from the accessory nerve--CN XI; it does not receive motor fibers from any spinal nerve.

3. The correct answer is: **C6**

There are 7 cervical vertebrae and 8 pairs of cervical nerves. So, the nerve from the C1 spinal cord segment emerges above the C1 vertebra, the nerve from the C2 region of the spinal cord emerges above the C2 vertebra, and so on. This means that if a disk presses the nerve between the C5 and C6 vertebrae, it will be compressing the C6 nerve,
which emerges above the C6 vertebra. So, what happens with the C8 nerve? Since there is no 8th cervical vertebra, the C8 nerve emerges above the T1 vertebra. Then, the nerve that comes out below the T1 vertebra is the T1 spinal nerve, and the nerve that emerges below the T2 vertebra is the T2 spinal nerve. The same holds true for the lumbar and sacral regions. Just remember: In the cervical region, a spinal nerve comes out above the vertebra of the same number, but in the thoracic, lumbar, and sacral regions, the spinal nerve comes out below the vertebra of the same number.

4. The correct answer is: C L5

This question asks you to think about the lumbar region where the spinal nerve comes out below the vertebra of the same number. If a disc herniates between L4 and L5, it will be impinging on the L5 spinal nerve. This is because the L4 nerve lies immediately below the L4 pedicle, above the herniating disc. However, the L5 nerve roots are already proceeding laterally toward the L5 intervertebral foramen, so it is usually caught by the herniating L4/5 disc. In the cervical region, the spinal nerves emerge above the vertebrae of the same number, while in the thoracic, lumbar and sacral region the spinal nerves emerge below the vertebrae of the same number. As well, cervical roots course nearly directly laterally to exit. So, although the result is similar (herniating discs compress the lower numbered vertebrae of the pair), the reasons are different for cervical regions and lower levels. Make sure to keep this difference straight, because it's an important one to remember!

5. The correct answer is: B thoracic

Kyphosis is an abnormal increase in the thoracic curvature of the vertebral column. An abnormal increase in lumbar curvature due to anterior sway of the pelvis is called lordosis. (Women develop temporary lordosis during pregnancy to compensate for the change in their normal line of gravity.) Finally, scoliosis is an abnormal lateral curvature of the spine accompanied by a rotation of vertebrae.
6. The correct answer is: C S2

Although the dural sac and subarachnoid space end at S2, the filum terminale externum (AKA coccygeal ligament) is a continuation of the dura mater that extends below the end of the dural sac to attach to the coccyx.

7. The correct answer is: D L4

In an adult, the spinal cord usually ends at the inferior border of L1 or the superior border of L2. Therefore, it is relatively safe to insert a needle above or below L4. At this level, the nerve roots are suspended in the CSF and can float away from the pressure of the needle, so these roots will not be damaged by the needle.

How can you find the L4 level on a patient? If you find the tops of the 2 iliac crests and draw a line connecting them, that line should be going through the spinous processes of the L4 vertebra.

8. The correct answer is: A arachnoid

The previous question stated that a myelogram is a radiograph taken following injection of a radio-opaque dye into the subarachnoid space. So, it should make sense that the arachnoid must be ruptured for the dye to leak out following this procedure. Denticulate ligaments are specializations of the pia mater that form a longitudinal shelf separating the dorsal and ventral rootlets. They suspend the spinal cord in the subarachnoid space. These ligaments would not be disturbed during a myelogram. Periostium is a fibrous connective tissue that invests bones, and perineurium is a connective tissue covering that encloses a fasicle of peripheral nerve fibers. The pia mater is the innermost covering of the
spinal cord. It closely follows the entire spinal cord and is not penetrated during a myelogram

9. The correct answer is: C or D pre- or postganglionic sympathetic

Somatic afferent neurons originate from the dorsal root and dorsal rootlets. If dorsal rootlets were avulsed, somatic afferent nerve fibers would be damaged. Somatic efferent neurons originate from the ventral root and ventral rootlets. If ventral rootlets were avulsed, somatic efferent nerve fibers would be damaged. Preganglionic (presynaptic) sympathetic neurons originate from the lateral horn of the spinal cord between the levels of T1 and L2. They exit the spinal cord through the ventral rootlets and eventually synapse at sympathetic ganglia. Since they travel through the ventral rootlets, the preganglionic sympathetic neurons would be damaged by the avulsion of ventral rootlets between T1 and L2, but not in cervical regions. The postganglionic sympathetic fibers would not be disrupted by avulsing the dorsal and ventral rootlets in any region. They originate in the sympathetic ganglia which are not a part of the spinal cord. (There will be much more to come on ganglia later on--stay tuned!)

10. The correct answer is: D sympathetic

The sympathetic nervous system is responsible for the vasoconstriction of peripheral vasculature. If the sympathetic nervous system was damaged, peripheral vessels would no longer be able to constrict. The resultant vasodilation would cause flushing. Somatic afferent, efferent, and parasympathetic fibers are not involved with the innervation of the vasculature. Disrupting any of these other fibers would not cause these symptoms.
11. The correct answer is: B adds about 1/4 the entire length to the vertebral column.

The intervertebral discs, consisting of an outer anulus fibrosus and an inner nucleus pulposis, add about 1/4 the length to the vertebral column. They act as shock absorbers between the vertebral bodies. The discs are not found between all adjacent vertebrae. There is no disc between the C1 and C2 vertebrae, and the most inferior disc is between L5 and S1. Discs are not synovial joints—they are cartilagenous joints (symphyses) designed to bear weight. The center of the disc, the nucleus pulposis, is highly elastic and compressible, but it is a cartilaginous structure, not liquid. Finally, the intervertebral disc is not penetrated to form a spinal tap. The needle only needs to penetrate the subarachnoid space to retrieve CSF.

12. The correct answer is: C gives origin to most of the cauda equina

Located at L2, the conus medullaris is the tapered termination of the spinal cord proper. Most of the cauda equina originate from the conus medullaris and then travel to the vertebral foramina inferior. Although the spinal cord exhibits both a cervical and a lumbar enlargement, the conus medullaris refers to the termination of the spinal cord, not the entire spinal cord.

There is no modified neural tissue extending from the termination of the conus medullaris to the coccygeal ligament. Instead, the filum terminal internum, which is a thread-like extension of the pia mater, extends from the conus medullaris. Eventually, this filum terminal internum becomes enclosed in the filum terminale externum, which is a thread-like extension of the dura mater extending below the end of the dural sac (at the S2 level). The filum terminal externum is what attaches to the coccyx, forming the coccygeal ligament.

The conus medullaris is located at L2, at the termination of the spinal cord. The dural sac, however, continues to the S2 level. (These are important levels to keep in mind!) Finally, the conus medularis is not
anesthetized to perform a spinal tap--hopefully, the needle used for a spinal tap won't even touch the conus medullaris!

13. The correct answer is: C Sensory from the skin overlying the trapezius

The dorsal root ganglia is the location of the cell bodies of somatic sensory neurons. Cells from the dorsal root ganglia transmit somatic sensation from areas like the skin to the central nervous system. A neuron with a cell body in the dorsal root ganglia might be involved in conveying sensory information from the skin overlying the trapezius.

Motor neurons have their cell bodies in the ventral horn of the spinal cord. They leave the spinal nerve through the ventral root, join a spinal nerve, and then divide into the ventral and dorsal primary rami. The dorsal primary rami innervate the deep back muscles, while the ventral primary rami innervate other muscles, including pectoralis major (which is innervated via the brachial plexus).

The cell bodies of preganglionic sympathetic fibers are found in the lateral horn of the spinal cord. Finally, visceral afferent sensation is not carried on somatic sensory neurons--instead, the sensation from the stomach is carried on special visceral afferent nerves which accompany sympathetic nerves.

14. The correct answer is: A is a modification of the pia mater

The denticulate ligaments are specializations of the pia mater that extend from the lateral surface of the pia, helping to suspend the spinal cord in the subarachnoid space. These ligaments form longitudinal shelves that separate the dorsal and ventral rootlets. There are only 21 pairs of denticulations, so they are not found between all dorsal and ventral rootlets. These ligaments are not continuously attached to the dural sac; instead, they appear between the dorsal and ventral rootlets. Radicular arteries arise as multiple branches of several vessels.
(vertebral, posterior intercostal, lumbar, and lateral sacral arteries) and accompany the ventral rootlets to reach the spinal cord. They do not have a special relationship with the denticulate ligaments.

15. The correct answer is: **A** crest of the ilium.

L4 is a relatively safe level for performing a lumbar puncture. Since the conus medullaris is at the inferior border of L1 or the superior border of L2, it should be safe to insert a needle either above or below L4. The anatomical landmark used to identify L4 is the top of the iliac crest. The line connecting the top of the two iliac crests, the supracristal line, passes through the spinous processes of the L4 vertebrae. So, by finding the tops of the iliac crests, you should be able to identify L4.

16. The correct answer is: **E** supraspinous.

To insert a needle into the subarachnoid space, the needle must pass through three ligaments: the supraspinous ligament, interspinous ligament, and ligamenta flava. The anterior longitudinal ligament is located along the anterior surfaces of all vertebral bodies--it lies directly posterior to the thoracic and abdominal viscera. The denticulate ligaments are paired ligaments that separate the dorsal and ventral rootlets. They are not disturbed during a lumbar puncture. Ligamentum nuchae is located at the nape of the neck--not even close to where you would perform a spinal tap. The posterior longitudinal ligament is a ligament on the posterior surfaces of the vertebral bodies. Although it is located in the vertebral canal, it is not penetrated by the needle during a spinal tap.

It's important to know the anatomy involved with a lumbar puncture! Look at the clinical case for further information about this important topic.

17. The correct answer is: **D** Internal vertebral venous plexus
The veins of the internal vertebral venous plexus are clinically significant because they are valveless and can serve as a route for metastases. Cancerous cells can travel freely in vertebral veins and lodge somewhere else in the body. The other veins all have valves which would direct the flow of blood and stop some of the metastatic spread.

18. The correct answer is: **cervical**

Remember: the first cervical nerve comes over the first cervical vertebra, and is labeled C1. But, the last cervical nerve comes below the seventh (and final) cervical vertebra. This nerve is labeled C8. So there are 8 cervical spinal cord segments but 7 cervical vertebrae. In all the other regions, the spinal nerve for a segment comes out below the vertebra of that same segment, giving 12 thoracic vertebrae and 12 thoracic spinal cord segments, 5 lumbar vertebrae and 5 lumbar spinal cord segments, and 5 sacral vertebrae and 5 sacral spinal cord segments.

19. The correct answer is: **C3, C4, and the accessory nerve**

C3, C4, and the accessory nerve (CN XI) all innervate the trapezius and comprise the subtrapezial plexus. The accessory nerve provides motor innervation to the trapezius, while C3 and C4 relay information about proprioception. As for the other nerves in the question—remember that the dorsal scapular nerve innervates the lower part of levator scapulae and all of rhomboideus major and minor, but it does not innervate the trapezius.

20. The correct answer is: **Yes**

The posterior longitudinal ligament is located along the posterior surfaces of all vertebral bodies. So, to penetrate the posterior longitudinal ligament, a needle would have to enter and exit the dura.
mater and the arachnoid mater. If you were really doing a spinal tap, however, you wouldn't want the needle to penetrate the posterior longitudinal ligament. Instead, you would want to stop and withdraw CSF upon entering the arachnoid space.

21. The correct answer is: D intervertebral foramen

A "slipped disk" is the herniation of the nucleus pulposis through the anulus fibrosis. This usually happens in a posterolateral direction. Once a disk herniates, it commonly puts pressure on the nerve roots or the dorsal root ganglion exiting the intervertebral foramen at or below its level. The vertebral canal or vertebral foramen is the opening formed by the combination of the body and vertebral arch. This is not the location where the disk is compressing nerves. The foramen magnum is an opening in the occipital part of the skull that transmits the spinal cord. The hiatus of the sacral canal is a normal feature that results from the failure of fusion of the laminae of the fifth sacral segment (and sometimes the fourth) during development.

22. The correct answer is: D erector spinae

Of all the answer choices, erector spinae is the only true back muscle listed. True back muscles act on the vertebral column, producing its movements and maintaining posture. These true back muscles are innervated by posterior (dorsal) primary rami. The other four muscles are superficial back muscles that aid with the movements of the limbs as well as with respiration. They mostly receive their nerve supply from the ventral rami of cervical nerves. Latissimus dorsi is innervated by the thoracodorsal nerve, which is made from branches of the ventral primary rami of C5 and C6. Levator scapulae and rhomboideus major are innervated by the dorsal scapular nerve, a branch of the ventral primary rami of C5. (The superior part of levator scapulae also receives some innervation from the ventral primary rami of C3 and C4.) Lastly, trapezius is innervated by the accessory nerve (CN XI) but also receives innervation from C3 and C4 ventral primary rami for proprioception.
23. The correct answer is: **D** 31

There are 31 segments of the spinal cord and 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal, for a total of 31.

There are 33 vertebrae arranged in 5 regions: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal. Motion only occurs among 24 vertebrae: the 7 cervical, 12 thoracic, and 5 lumbar. (The sacral and coccygeal vertebrae are usually fused.)

24. The correct answer is: **D** Pia mater

The pia mater is the innermost covering of the spinal cord which is closely applied to the entire spinal cord. It does not need to be pierced to retrieve CSF. This fluid is found in the subarachnoid space, outside of the pia mater. The needle must pass through the following layers during a lumbar puncture: skin, fat, supraspinous ligament, interspinous ligament, between or through the ligamenta flava, epidural fat and veins, dura, subdural space, and arachnoid.

25. The correct answer is: **E** posterior

In kyphosis, the accentuated convexity of the curvature is in a posterior direction. The accentuated convexity of curvature in lordosis is in the anterior direction.

26. The correct answer is: **E** subarachnoid space at the level of L4
There are 2 issues to think about here. First, from what compartment is the CSF removed? Second, at what level should the needle be inserted in a spinal tap? CSF is removed from the subarachnoid space. The epidural space contains epidural fat, and the subdural space is a potential space only. Also, remember that a lumbar puncture should be performed at the level of L4. Because the spinal cord ends at the bottom of L1 or the top of L2, L4 is a safe level for inserting a needle.

27. The correct answer is: D sympathetic nerve fibers

The sympathetic nerve fibers control the tone of the vasculature and allow for vasoconstriction. If these fibers are damaged, vessels will not be able to vasoconstrict and they will dilate, producing a flush. The cranial outflow of the autonomic nervous system refers to parasympathetic nervous fibers, which do not control the tone of the vasculature. Dorsal roots of cervical nerves carry afferent sensory fibers, not sympathetic neurons. The grey rami communicantes are structures that postganglionic sympathetic neurons travel on before rejoining a spinal nerve, so destroying the grey rami communicantes might disrupt the sympathetic outflow. This could be a good answer, except that the T5 spinal nerve will have no effect on the side of the face. Finally, the vagus nerve is a cranial nerve with mixed motor and sensory fibers which carries parasympathetic fibers to many organs. There is much more to come on all of these topics!

28. The correct answer is: C Below the pedicle of L4 and at the top of the intervertebral foramen

Remember, in the lumbar region, spinal nerves exit below the vertebra with the same number. So, the L4 nerve exits below the L4 vertebra. The spinal nerves also exit at the top of the intervertebral foramen.
29. The correct answer is: **B** Dorsal root of T6

The dorsal root of a spinal nerve contains afferent sensory nerve fibers and no efferent autonomic nerve fibers. The efferent autonomic nerve fibers, which originate in the lateral horn of the spinal nerve, travel out of the spinal cord through the ventral root of the spinal nerve. As the ventral and dorsal roots join to form the spinal nerve, the fibers from both roots intermingle, and the dorsal and ventral primary rami take a mix of fibers, including afferent sensory fibers from the dorsal root, and efferent motor fibers from the ventral root. Postganglionic sympathetic efferent fibers join each spinal nerve via a gray ramus communicans. So, all of the other nerves listed do contain efferent autonomic fibers.

30. The correct answer is: **B** Laminae, spinous processes, and ligamenta flavum

This is straight from lab: To expose the spinal cord, it was necessary to remove the laminae, spinous processes, and ligamenta flavum. The supraspinous ligament and the interspinous ligament also needed to be removed.

31. The correct answer is: **B** T12-L2

In adults, the conus medullaris is normally positioned between T12 and L2. This is why it is safe to do a lumbar puncture at the level of L4.

32.

The correct answer is: **D** Dura mater

Crossing the dura mater would cause a "pop" that might be heard while doing a spinal tap. The dura is the toughest covering over the spinal
cord, so it is difficult to penetrate it with a needle. Intervertebral discs and the anterior longitudinal ligament would not be disrupted during the spinal tap. Although you would cross the ligamentum flavum and the arachnoid mater with the needle, penetrating those structures would not lead to the popping noise. The ligamentum flavum is made of elastic fibers and is not tough enough to cause the "pop." The arachnoid mater is a thin and fragile layer that would be easy for a needle to penetrate.

33. The correct answer is: B vertebral venous plexus

A valveless venous system, the internal vertebral venous plexus is clinically significant because it can transmit cancer metastases to distant locations. The anterior spinal artery and vertebral arteries would not be the route for cancer cells to reach the brain. The azygos system contains valves and would carry blood toward the heart and lungs, not toward the brain. Finally, the thoracic duct is a major channel for lymph flow to reenter the circulation. Although cancer cells may be carried by lymphatics, the thoracic duct would not direct cancer to the brain.

34. e correct answer is: A It is also known as the artery of the lumbar enlargement

The artery of Adamkiewicz is also known as the great radicular artery. It is frequently found of the left side in the lower thoracic or upper lumbar region. Like all other radicular arteries, it must run with rootlets to reach the spinal cord. The great radicular artery anastomoses on the surface of the thoracic spinal cord and it serves as a major blood supply for the lower spinal cord. In fact, disruption of this artery may lead to paraplegia due to death of the lumbar and sacral portions of the spinal cord.

35. The correct answer is: E Ventral horn of the spinal cord
The cell bodies of the motor neurons are found in the ventral horn of the spinal cord. Since these are the cells that are being degraded in ALS, which is destroying the voluntary motor system, this is the place where you would expect to see the atrophied cell bodies.

The dorsal horn of the spinal cord contains the cell bodies that the afferent sensory neurons synapse on before the neural signal ascends the spinal cord. The dorsal root ganglion contains the cell bodies for the somatic sensory neurons. The lateral horn of the spinal cord contains the cell bodies of the presynaptic sympathetic neurons. The sympathetic chain ganglion contains the cell bodies of the postsynaptic sympathetic neurons. Remember--sympathetic neurons can provide motor innervation to structures, but not voluntary motor innervation!

36. The correct answer is: C Laminae and ligamenta flava, epidural space, dura, subdural space, arachnoid, subarachnoid space, pia.

The surgeon needs to remove all the coverings of the spinal cord to reach the veins on the posterior surface of the cord. So, the surgeon would remove the lamina, a broad, flat plate of bone located between the transverse process and the spinous process of the vertebra. The surgeon would NOT remove the pedicles, which are short strong processes that extend posteriorly from the posterolateral surface of the vertebral body to connect the body with the transverse processes. The pedicles are far too deep in the back to be removed! The surgeon would now pass through the ligamenta flava, which is an elastic ligament which joins the laminae of adjacent vertebrae.

Then, the surgeon would cross through the coverings of the spinal cord and associated spaces, starting with the epidural space, continuing with the dura mater, subdural space, arachnoid mater, subarachnoid space, and finishing with the pia mater.

Remember--the posterior longitudinal ligament extends over the posterior side of the vertebral bodies--it does not need to be penetrated to reach the spinal cord!
37. The correct answer is: **C** iliaceous crest

L4 is a relatively safe level for performing a lumbar puncture. Since the conus medullaris is at the inferior border of L1 or the superior border of L2, it should be safe to insert a needle either above or below L4. The anatomical landmark used to identify L4 is the top of the iliaceous crest. The line connecting the top of the two iliaceous crests, the supracrestal line, passes through the spinous processes of the L4 vertebrae. So, by finding the tops of the iliaceous crests, you should be able to identify L4.

38. The correct answer is: **C** ligamentum flavum

Ligamentum flavum is an elastic ligament which joins the laminae of adjacent vertebrae. So, to remove the laminae of two adjacent vertebrae, this ligament must be removed. The anterior longitudinal ligament is a ligament that courses from superior to inferior along the anterior surfaces of all vertebral bodies, lying directly posterior to the abdominal and thoracic viscera. Denticulate ligaments are lateral extensions of pia mater from the spinal cord—they attach to the dura mater to anchor the spinal cord. Ligamentum nuchae is a midline ligament that extends posteriorly from the spinous processes of cervical vertebrae—it is only found over the neck, so it wouldn't necessarily have to be removed if the laminectomy was in the lumbar or thoracic regions. The posterior longitudinal ligament is analogous to the anterior longitudinal ligament; it courses from superior to inferior along the posterior surfaces of all vertebral bodies.

39. The correct answer is: **C** epidural space

A caudal anesthesia is administered by a catheter inserted through the sacral hiatus. Anesthetic is placed in the catheter, and the anesthetic
bathes the sacral nerve roots. The catheter is in the epidural space, and this is where the anesthesia is placed.

The central canal of the spinal cord is a space in the spinal cord through which CSF circulates. The dural sinuses are venous sinuses found in the brain--this is where blood drains from the brain. The subarachnoid space is found under the arachnoid mater; this is the space where the cerebrospinal fluid circulates around the spinal cord. Finally, the subdural space is a space between the dura and arachnoid mater--this is a potential space only!