

INTERNATIONAL SURGICAL  
ANATOMY TEACHING  
SERIES



# ISATS HANDOUT 2023/24

Neuroanatomy: Spine

# SPINE ANATOMY

**Objectives:** To understand the bony anatomy, ligaments, neural contents and vascular supply of the vertebral column and spinal cord. Apply anatomical knowledge to the setting of neurosurgical procedures including a laminectomy, discectomy or lumbar puncture

## Bony Anatomy

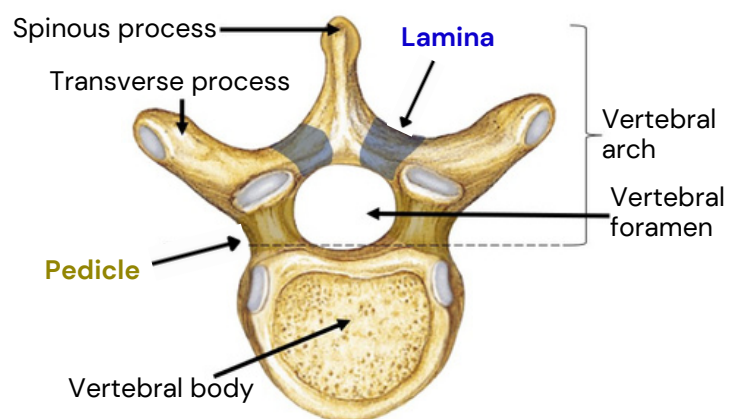
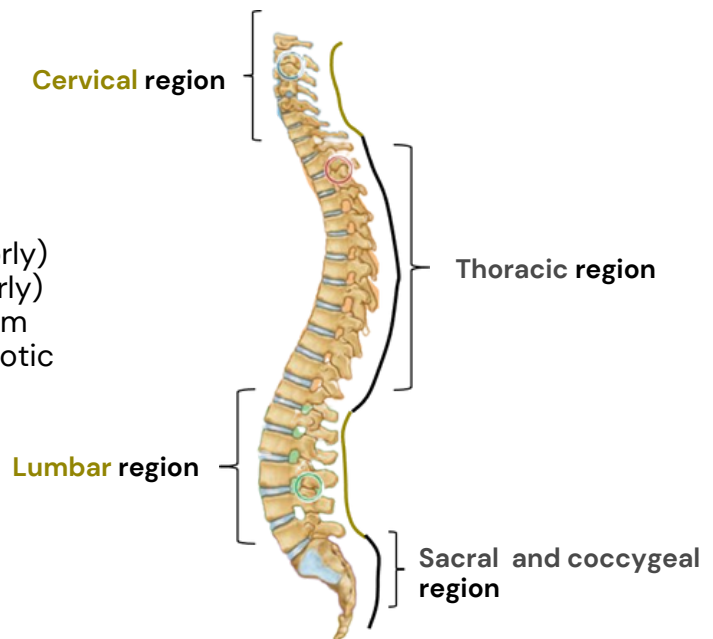
### Spine curvature

- The spine has two main curvatures:
  - **Kyphotic** – thoracic and sacral
  - **Lordotic** – cervical, lumbar and coccygeal
- Primary curvatures are kyphotic (concave anteriorly)
- Secondary lordotic curvatures (concave posteriorly) develop from extension of the neck and bipedalism
- Increased age regresses the spine to mainly kyphotic curves due to decreased bone mass

### Typical Vertebra Features

- Vertebral body** – anterior spinal cord protection
- Vertebral arch** – protection and support
- Pedicle** – joins body and arch (transverse processes)
- Transverse process** – muscle and ligamentous attachments
- Spinous process** – increasingly posteroinferior projection when observing spinal column from superior to inferior direction
- Lamina** – connects the transverse and spinal processes.

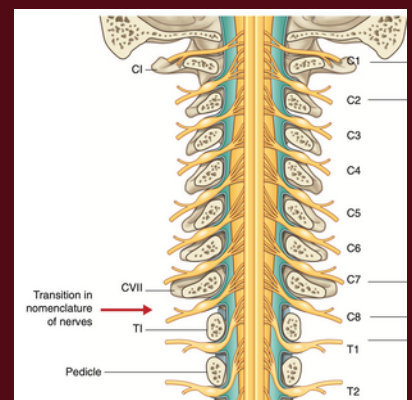
All structures unite to form a hollow, **vertebral foramen** along the spinal column which encloses the spinal cord.



## Spinal levels

- Spinal nerves exit inferior to their corresponding vertebra, e.g. T1 nerve below T1 vertebra
- Except** in the cervical region where spinal nerves exit superior to their corresponding vertebra
- Hence there is a C8 nerve but **NO** C8 vertebra

Regions	Vertebrae	Spinal nerves
<b>Cervical</b>	C1 to C7	C1 to C8*
<b>Thoracic</b>	T1 to T12	T1 to T12
<b>Lumbar</b>	L1 to L5	L1 to L5
<b>Sacral</b>	S1 to S5	S1 to S5
<b>Coccyx</b>	Co1	Co1



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[Continued typical features]

- **Articular process** - located at the intersection between pedicles and lamina.
  - Superior and inferior articular processes join to form zygapophyseal joints [**synovial plane joint**]
  - These joints allow for articulation with adjacent vertebrae

## Region-specific unique features

### Cervical Vertebrae

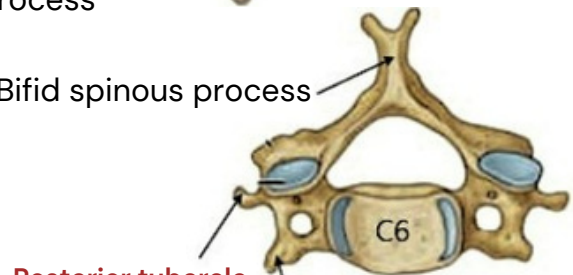
- **Bifid spinous process**
- Except C7 (has a long, non-bifid process) and C1 (no spinous process)
- **Anterior and posterior tubercles of transverse process** - cervical muscle attachment sites
- **Transverse foramen** - opening in each transverse process that is occupied by the sympathetic plexus, vertebral artery and vein
  - Except C7 (does not contain the vertebral artery - only **small accessory veins**)
- **Uncinate process** - facilitates flexion and extension, limits lateral flexion
  - Present between C3 to T2
  - Forms **uncovertebral joints**
  - Common site for **osteophyte formation**
    - Impinges spinal nerves
    - Uncinectomy procedure for palliation

Superior articular process



Inferior articular process

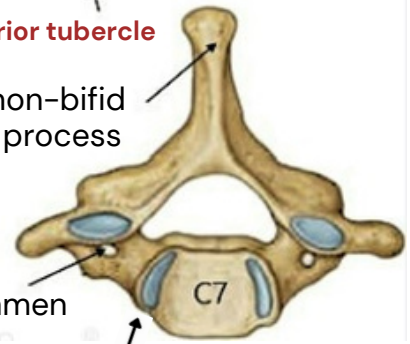
Bifid spinous process



Posterior tubercle

Anterior tubercle

Round, non-bifid spinous process



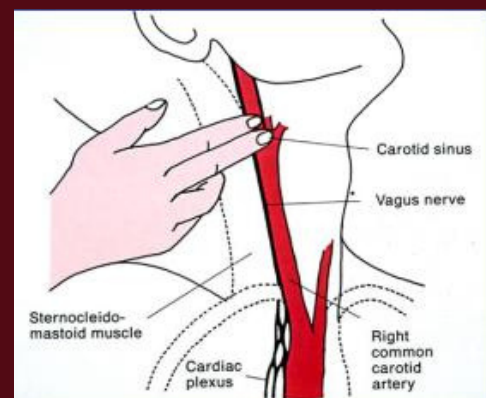
Transverse foramen

Uncinate process

## Chassaignac's tubercle

- Eponymous name for **C6 anterior tubercle**
- Key clinical landmark for:
  - Performance of vagal manoeuvres such as carotid sinus massage to terminate

Skin -> **Supraventricular attachment** -> Intercostal m. -> **Stellate ganglion** -> **Neurovascular bundle** -> **Endothoracic fascia** -> **Parietal pleura**

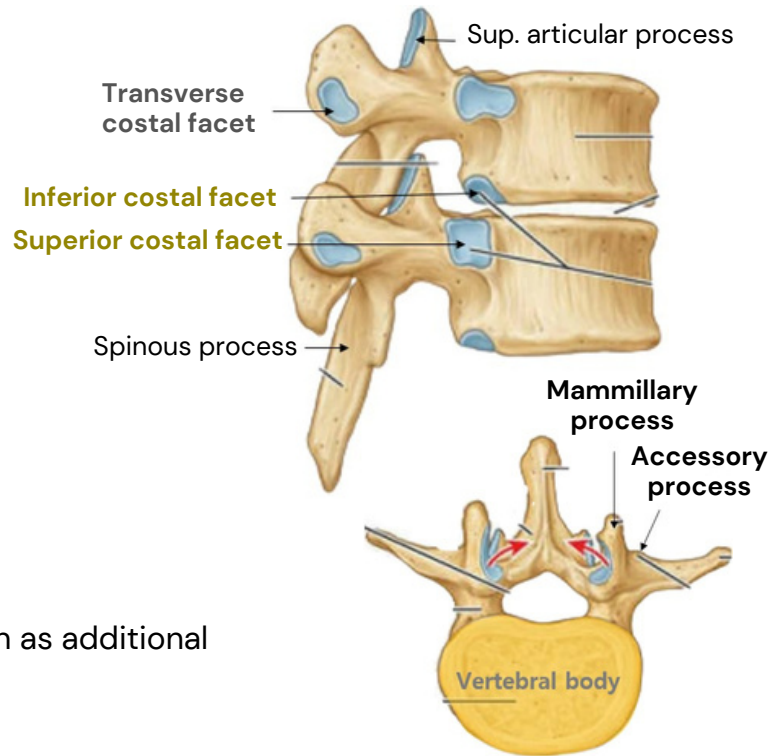


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## Thoracic Vertebrae

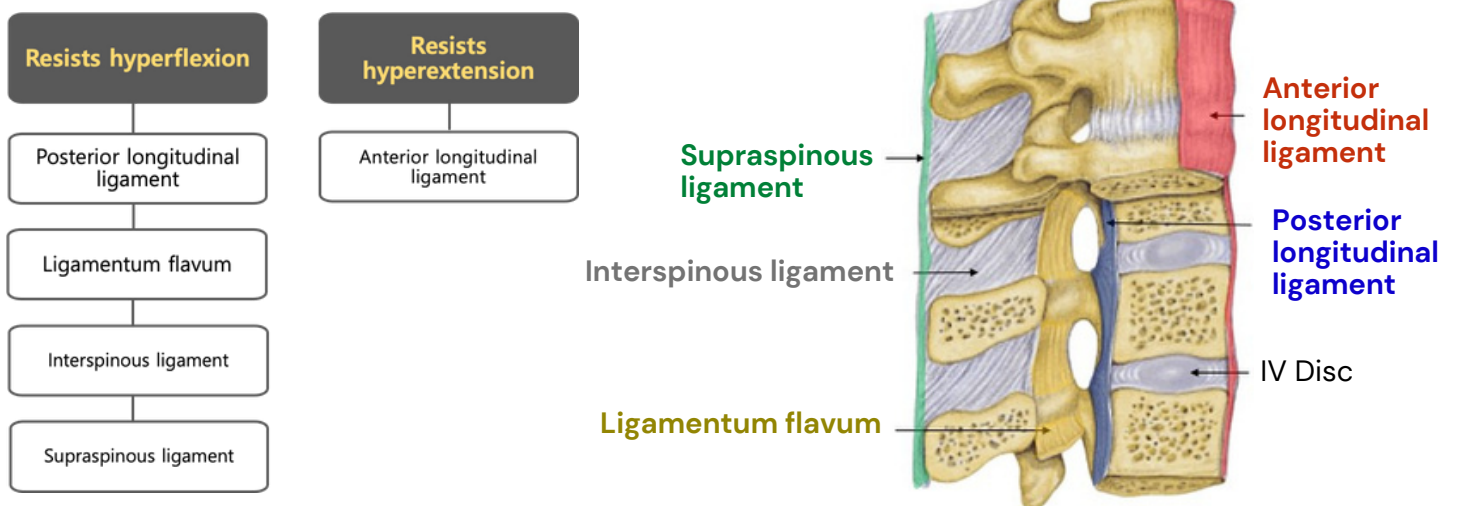
- The twelve thoracic vertebrae are all characterised by their articulation with ribs
- 3 costal facets
  - **Superior costal facets** - articulates with corresponding rib head
  - **Inferior costal facet** - articulates with the head of the rib below
  - **Transverse facet** - articulates with tubercle of corresponding rib
- T12 is commonly fractured due to transitional vertebra features.



## Lumbar Vertebrae

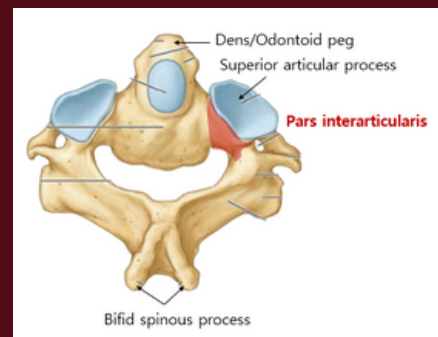
- Large, kidney-shaped vertebral body
- **Accessory** and **mammillary process** function as additional muscle attachment sites

## Vertebral Column Ligaments



## Pars interarticularis

- **Pars interarticularis** is the column between the superior and inferior articular process in zygapophyseal joints
- Prone to concentration of mechanical force, therefore common site for trauma localisation
- A defect in this leads to spondylolysis and spondylolisthesis. This can be unilateral or bilateral
- Bilateral C2 pars fractures are referred to as Hangman fractures. Typically occurs as a result of high velocity hyperextension and distraction of the head.

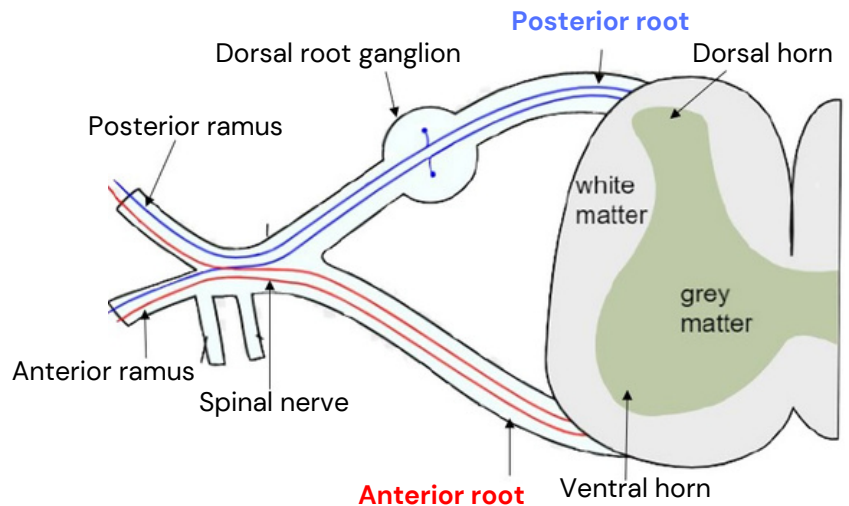


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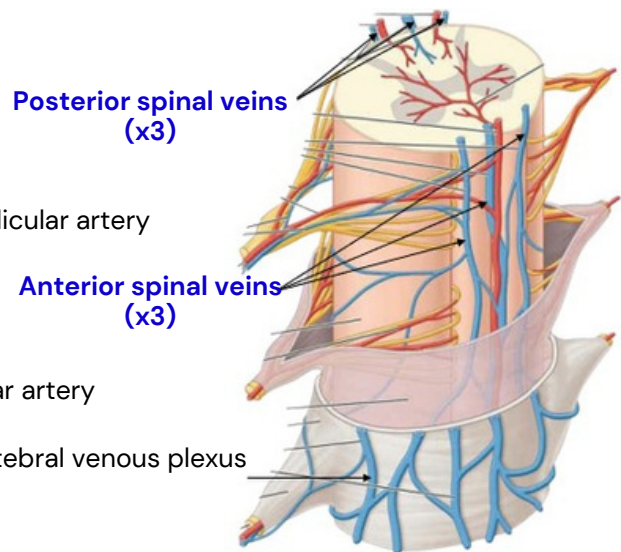
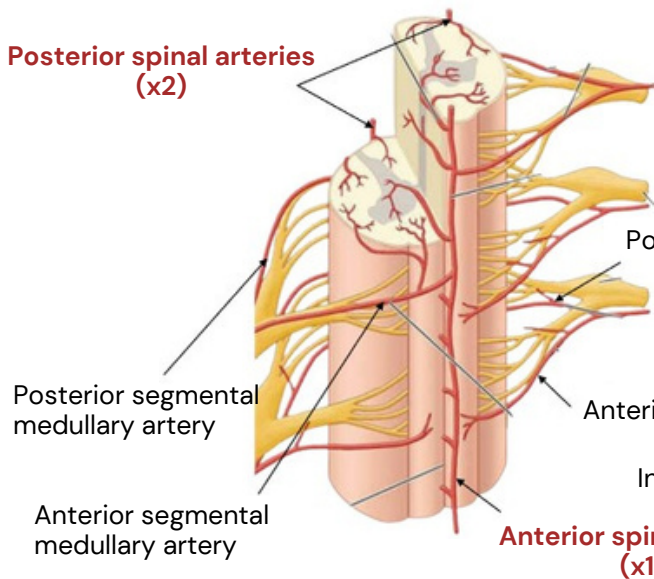
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## Peripheral nerve pathway

- Afferent sensory nerves enter dorsal horn via **posterior root**
- Synapse with interneuron between dorsal and ventral horn
- Exits via **anterior root** through efferent motor neuron which innervates distal skeletal muscles
- Central canal contains cerebrospinal fluid

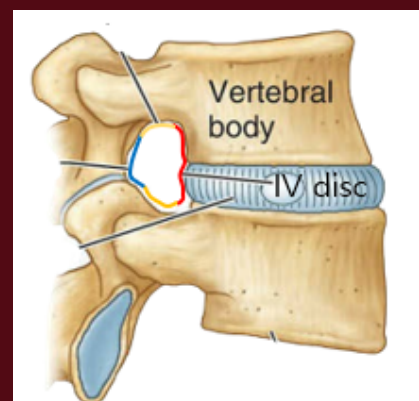


## Vascular supply



## Intervertebral foramen

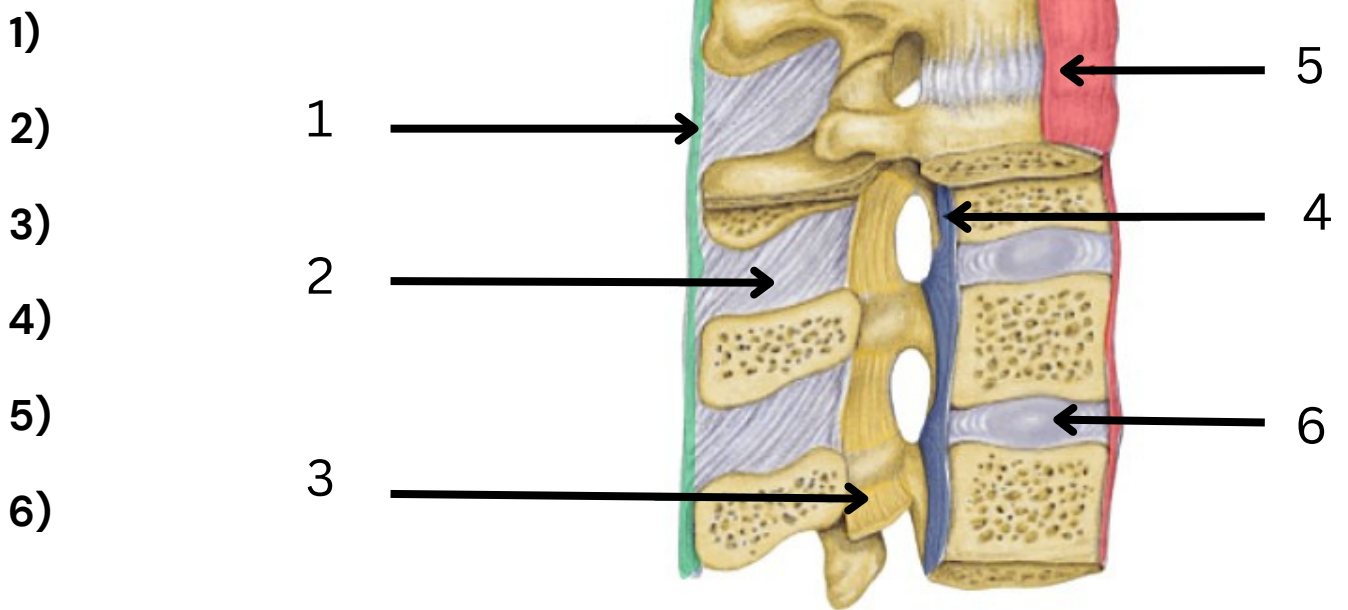
Boundaries	Structure
<b>Anterior</b>	Posterolateral aspect of corresponding vertebral body + IV disc
<b>Posterior</b>	Zygapophyseal joint + joint capsule
<b>Superior</b>	Inferior vertebral notch of superior vertebrae
<b>Inferior</b>	Superior vertebral notch of inferior vertebrae



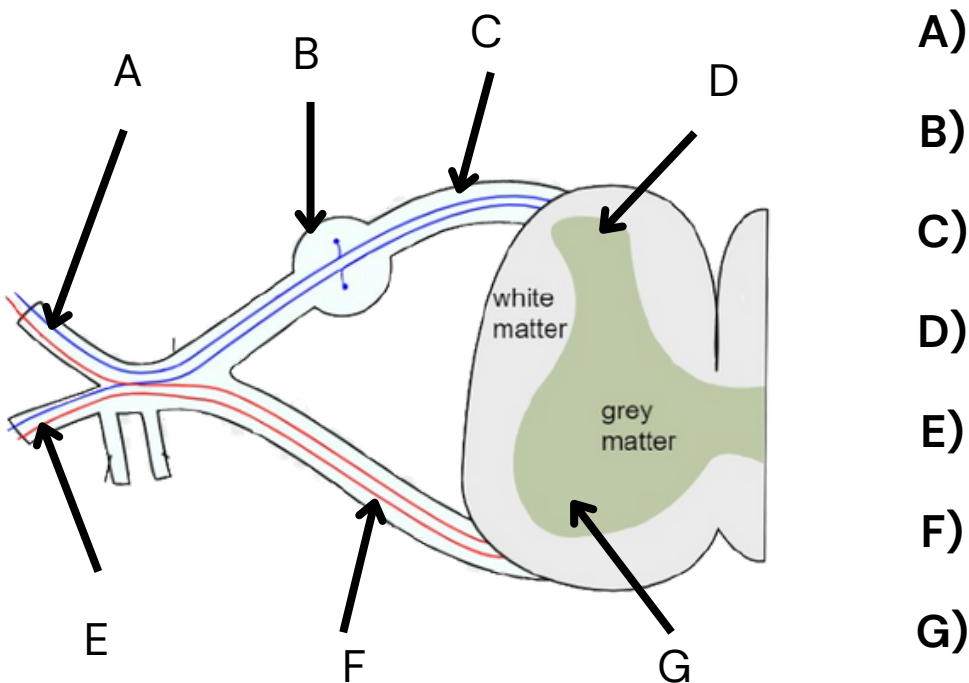
# SPINE ANATOMY

## Test yourself

1) Label the structures:



2) Label the spinal cord section:



# SPINE ANATOMY

## Test yourself

### MCQ 1

in relation to the cervical vertebra, the exiting nerve root is found:

- A. Immediately superior to the pedicle
- B. Immediately inferior to the pedicle
- C. At the midpoint between the superior and inferior level pedicles
- D. Nerve root has no anatomic relationship to the pedicles
- E. None of the above

### MCQ 3

Which option best describes the features of a thoracic vertebrae?

- A. Large kidney-shaped body, round vertebral canal, prominent mammillary process
- B. Circular vertebral body, round vertebral canal, costal facets on vertebral body**
- C. Triangular vertebral body, round vertebral canal, non-bifid spinous process
- D. Rectangular vertebral body, triangular vertebral canal, bifid spinous process
- E. Large kidney-shaped vertebral body, oval vertebral canal, accessory transverse process

### MCQ 5

Which structure connects the vertebral body to the transverse processes of the vertebral arch

- A. Pedicle**
- B. Transverse process
- C. Spinous process
- D. Laminae
- E. Vertebral disk

### MCQ 2

When performing a lumbar puncture what layers does the needle need to penetrate? prior to meeting the meningeal layers?

- A. ALL, PLL, Ligamentum flavum
- B. ALL, PLL, interspinous ligament
- C. Supraspinous ligament, interspinous ligament, ligamentum flavum**
- D. Supraspinous ligament, interspinous ligament, PLL
- E. Interspinous ligament, ligamentum flavum, supraspinous ligament

### MCQ 4

Which of the following structures is not found in the intervertebral foramen?

- A. Adipose tissue
- B. Recurrent meningeal nerve
- C. Dorsal root ganglion
- D. Supraspinous ligament**
- E. Intervertebral veins

### MCQ 6

Lumbar punctures are clinically safe to carry out where the spinal cord ends, below the conus medullaris. At what level does the spinal cord end?

- A. L5/S1
- B. L1/2**
- C. L2/3
- D. L3/4
- E. L4/5

# SPINE ANATOMY

## Test yourself

### OSCE Station – Case Based Discussion

A 54-year-old man presents to his GP with unilateral leg pain, which has been progressing in severity for the last 6 months, associated with mild weakness of the left leg on any activity. The pain radiates posteriorly down the patient's left leg and is worse on walking, even for a few metres, and usually forces the patient to stop and sit down to recover. The pain seems to improve once the patient sits down or crouches down. Back and neurological examination is unremarkable.

The patient denies any history of smoking or cardiovascular conditions and his body mass index is 19.0 kg/m<sup>2</sup>



**Q1. What is the most likely diagnosis?**

**List two potential differential diagnoses for this presentation;**

**Q2. What is the gold standard investigation to perform for your most likely diagnosis?**

**Q3. What would be most appropriate surgical treatment for this patient?**

**Q4. What other conditions would benefit from the surgical procedure in Q3?**

**Q5. What are the risks of the surgical treatment mentioned in Q3?**

**Answers**  
 Label: 1) Supraspinous 2) Interspinous 3) Ligamentum flavum 4) Posterior longitudinal 5) Anterior longitudinal 6) IV disc A) Posterior root B) Dorsal root ganglion C) Posterior root D) Dorsal horn E) Anterior root F) Anterior root G) Ventral horn  
 MCQs: 1) E, 2) C, 3) E, 4) D, 5) B, 6) C  
 OSCes: 1) Lumbar Spinal Stenosis is the diagnosis. Differentials include: peripheral arterial disease, mechanical back pain. 2) MRI scan is gold standard for demonstrating canal narrowing. 3) Laminectomy. 4) Herniated disc, Ankylosing spondylitis, Spondylitis (spinal osteoarthritis), Sciatica symptoms, primary spinal tumours, metastatic spinal cord compression 5) Post op haematoma, infection, nerve root damage, CSF leak, spinal cord injury, DVT,