

INTERNATIONAL
SURGICAL ANATOMY
TEACHING SERIES



ISATS HANDOUT 2025/26

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

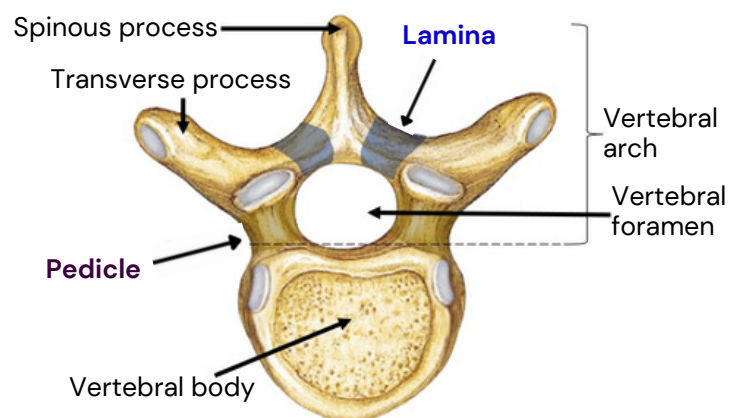
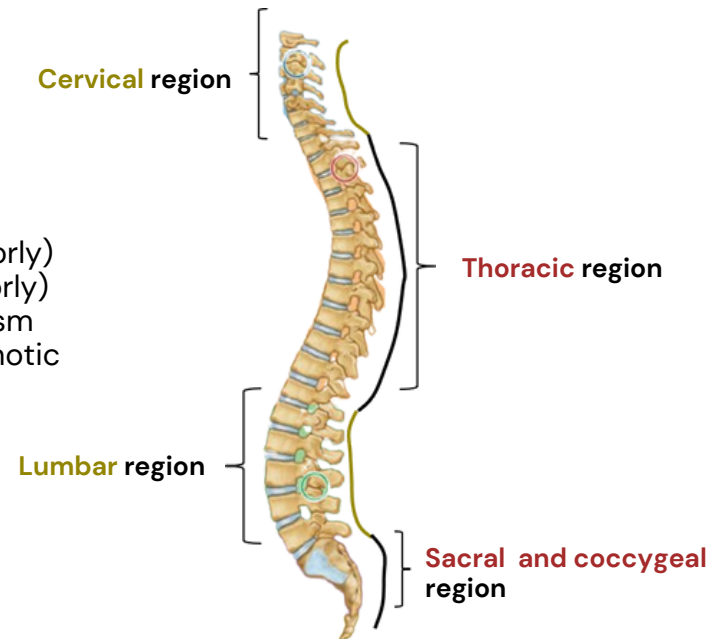
Spine curvature

- 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.

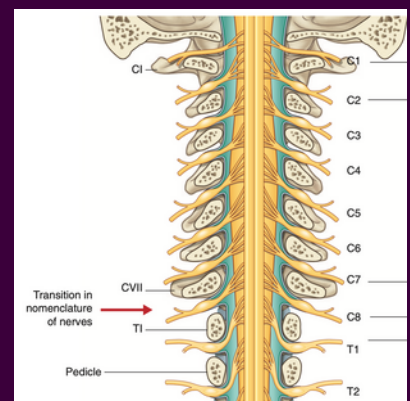
All structures unite to form a hollow, **vertebral foramen** along the spinal column which encloses the spinal cord.



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
Cervical	C1 to C7	C1 to C8*
Thoracic	T1 to T12	T1 to T12
Lumbar	L1 to L5	L1 to L5
Sacral	S1 to S5	S1 to S5
Coccyx	Co1	Co1



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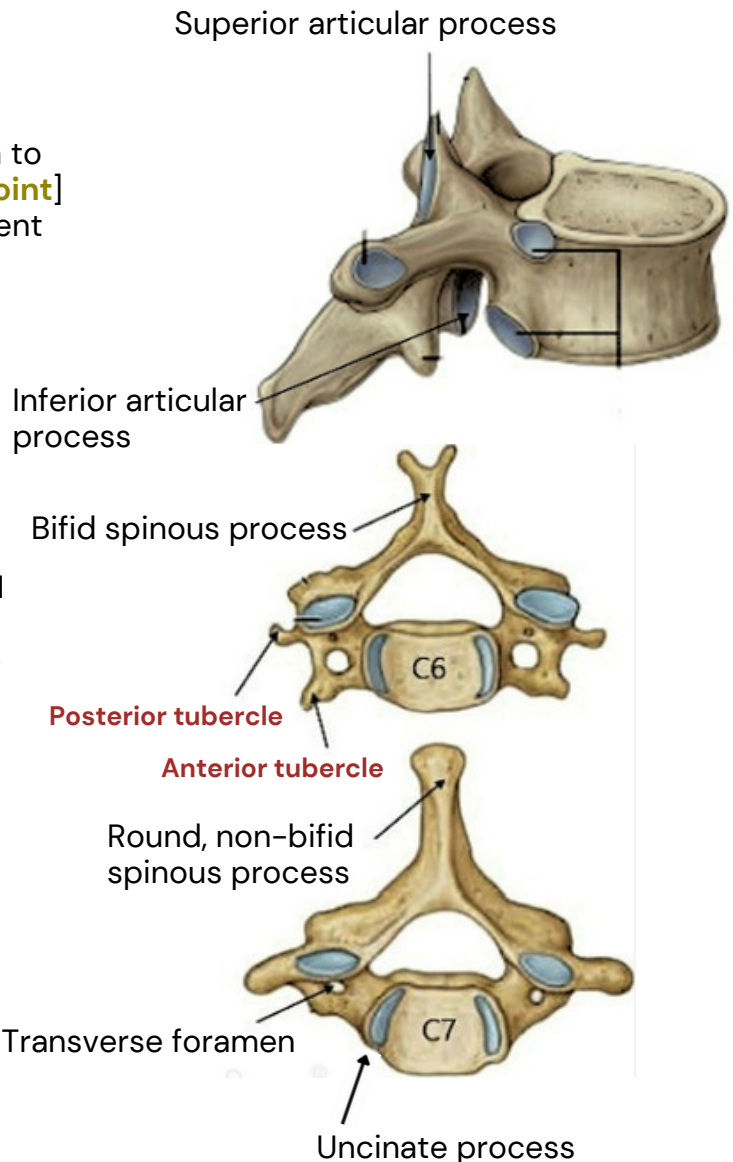
[Continued typical features]

- **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

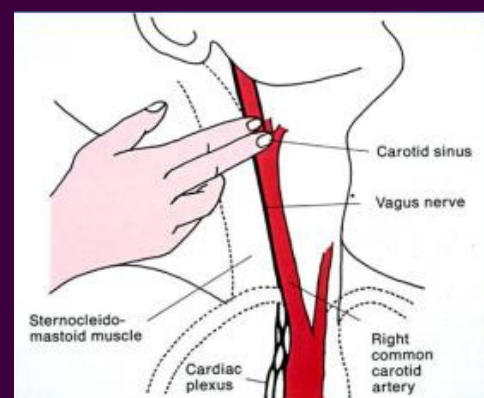
Cervical Vertebrae

- **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



Chassaignac's tubercle

- Eponymous name for **C6 anterior tubercle**
- Key clinical landmark for:
 - Performance of vagal manoeuvres such as carotid sinus massage to terminate supraventricular tachycardia
 - Stellate ganglion block to relieve head and neck pain

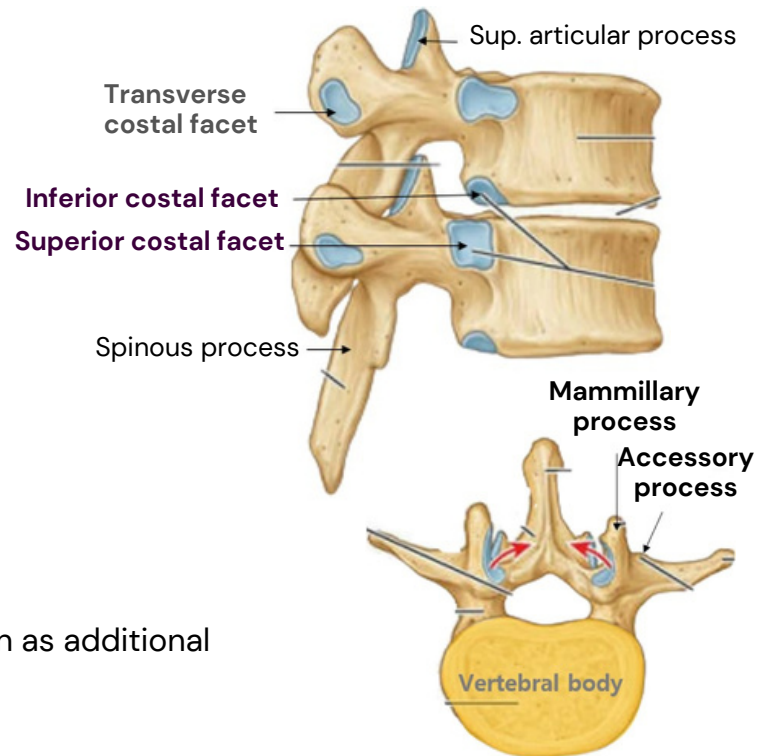


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Thoracic Vertebrae

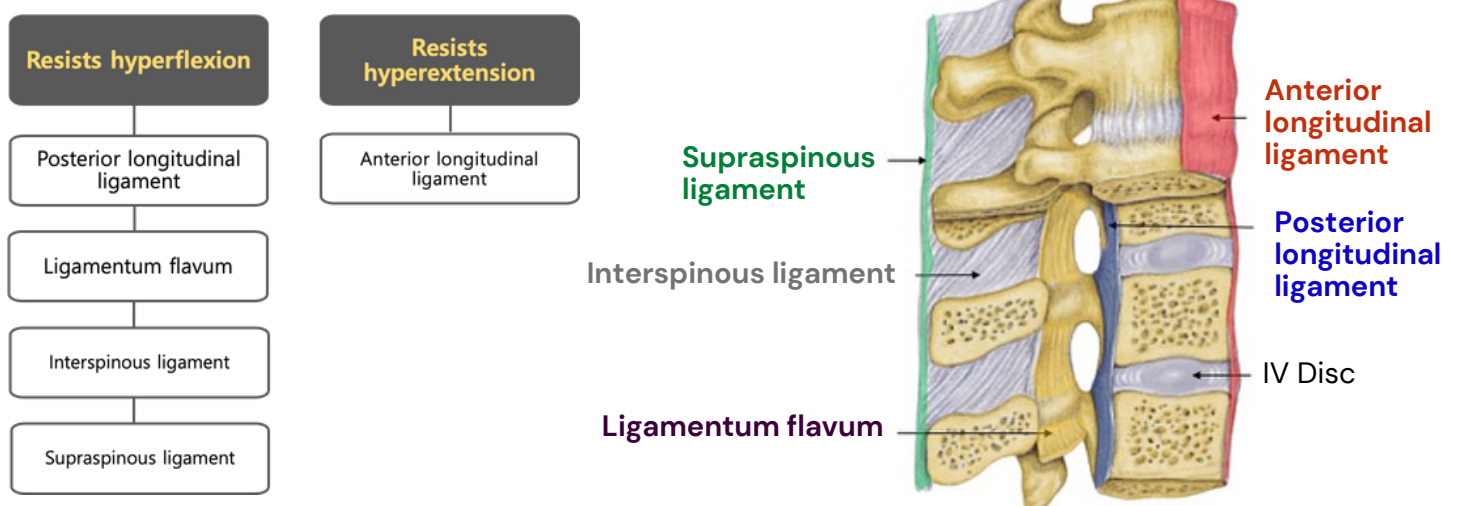
- The twelve thoracic vertebrae are all characterised by their articulation with ribs
- 3 costal facets
 - Superior costal facets** – articulates with corresponding rib head
 - Inferior costal facet** – articulates with the head of the rib below
 - Transverse facet** – articulates with tubercle of corresponding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



Lumbar Vertebrae

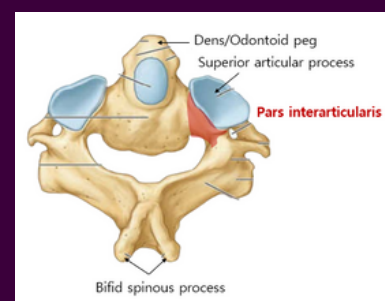
- Large, kidney-shaped vertebral body
- Accessory** and **mammillary process** function as additional muscle attachment sites

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.

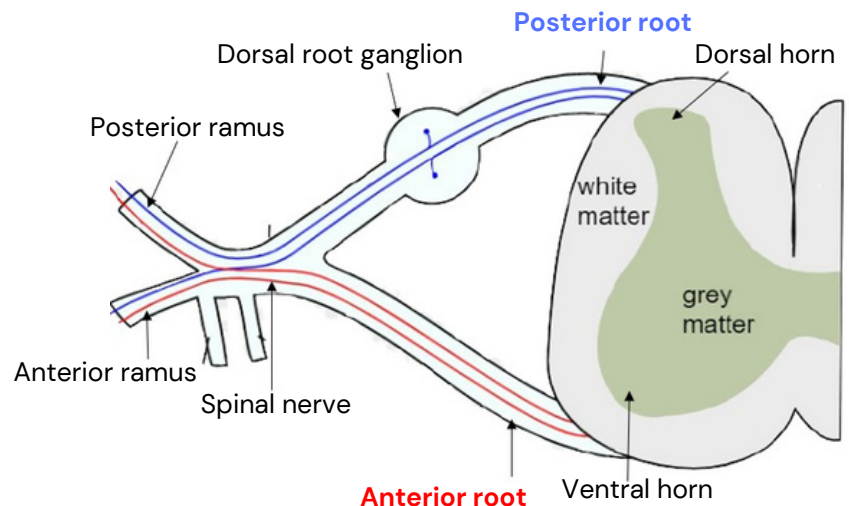


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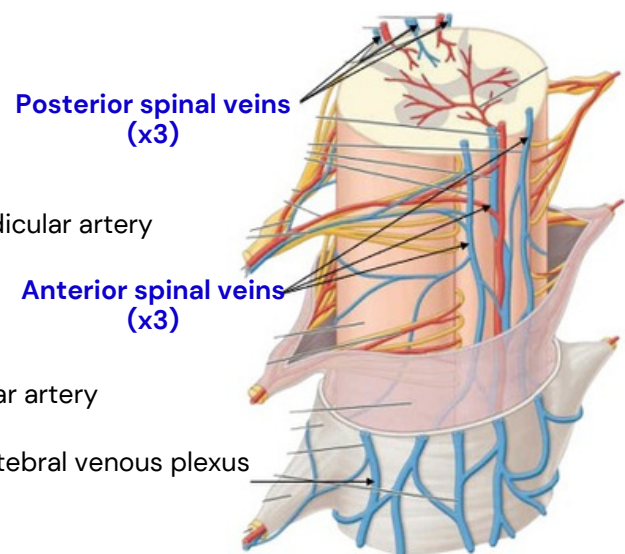
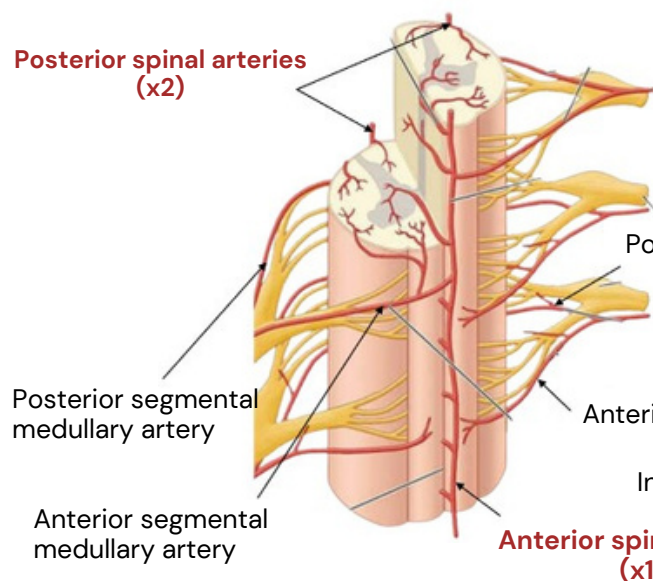
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Peripheral nerve pathway

- 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

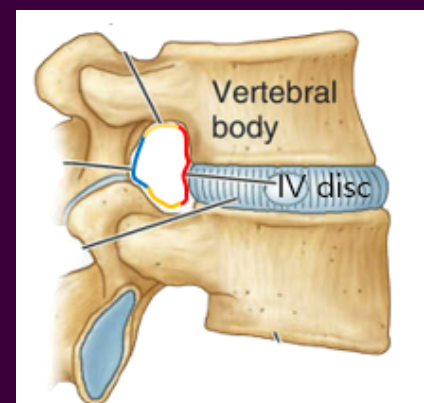


Vascular supply



Intervertebral foramen

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

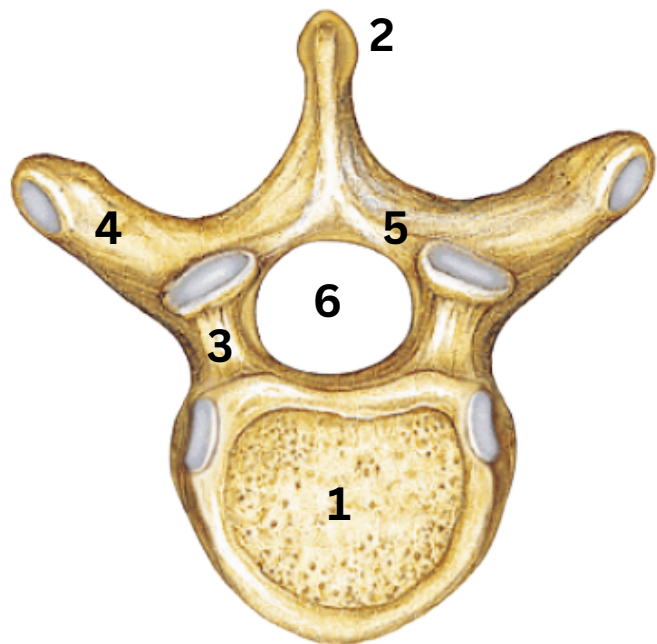


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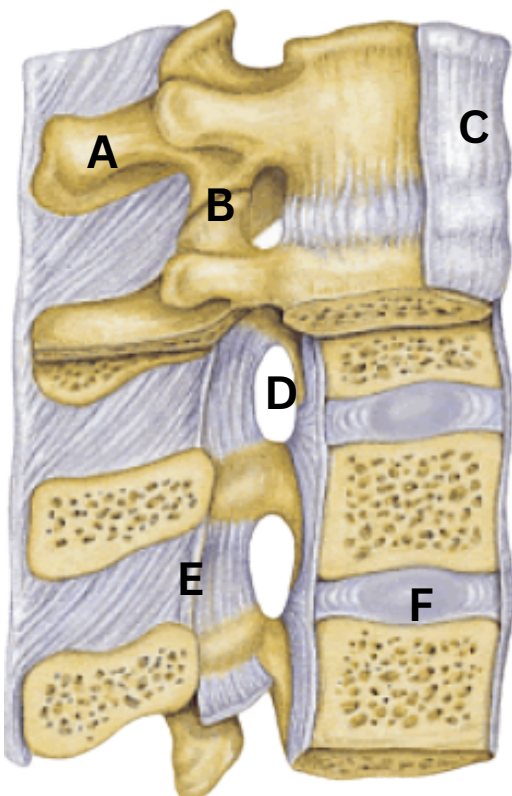
Test yourself

1) Label this vertebra:

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)



2) Label this lateral view of the vertebral column



- A)
- B)
- C)
- D)
- E)
- F)

SPINE ANATOMY

Test yourself

MCQ 1

In relation to the lumbar pedicle, 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 2

Which of the following structures does not pass through the intervertebral foramen?

- A. Recurrent Meningeal nerve
- B. Segmental Spinal arteries
- C. Supraspinous ligament
- D. Adipose tissue
- E. Dorsal root ganglion

MCQ 3

A 85 year old female presents to A&E with sudden onset paraparesis. On examination the patient had hypotension, bowel and bladder dysfunction. Neurological examination reveals loss of pain and temperature below T9 vertebral level, but preservation of proprioception and vibration sensation. Spinal cord infarct is suspected. What is most likely to be affected?

- A. Left posterior spinal artery
- B. Artery of Adamkiewicz
- C. Right posterior spinal artery
- D. Radicular veins
- E. Posterior segmental medullary arteries

MCQ 4

The lumbar puncture is performed in which space?

- A. Subdural
- B. Subarachnoid
- C. Epidural
- D. Intramedullary
- E. None of the above

MCQ 5

The cauda equina consists of which of the following structures?

- A. Lower end of spinal cord
- B. Filum terminale only
- C. Lumbar and sacral nerve roots
- D. Ventral root of the first spinal nerve
- E. Vascular supply to the spinal cord.

MCQ 6

A 48 year old man presents following acute onset back pain. On examination he has unilateral, decreased sensation on the posterolateral aspect of the right leg and lateral foot. A straight leg raise was positive and there was weakness on plantar flexion and reduced ankle reflexes. Which root is compressed?

- A. L3 nerve root compression
- B. L4 nerve root compression
- C. L5 nerve root compression
- D. S1 nerve root compression
- E. S2 nerve root compression

SPINE ANATOMY

Test yourself

OSCE Station – Case Based Discussion

A 25-year-old male, previously fit and well is involved in a high speed road traffic accident. He is conscious, oriented, and breathing spontaneously but cannot move or feel his legs. The examination findings are:

- Tone: Flaccid below lesion (spinal shock)
- Motor: Flaccid paralysis of both lower limbs (0/5)
- Reflexes: Knee & ankle jerks absent, plantar mute
- Sensory loss: Below nipple line → T4 dermatome
- Bladder: Retention, absent anal tone
- Spine: Tenderness mid-thoracic region



Q1 What is the neurological level of injury?

Q2. What is the most likely diagnosis?

Q3. What are the immediate steps in management?

Q4. What imaging is essential?

Q5 What is spinal shock?

Q6. What is the definitive management?

Q7. What pharmacologic adjunct may be considered early?

Answers
 Labels: 1) Vertebral Body 2) Spinous Process, 3) Pedicle 4) Transverse process, 5) Lamina 6) Vertebral Foramen
 A) Spinous Process B) Zygapophysial Joint, C) Anterior Longitudinal ligament, D) Intervertebral foramen, E)
 Ligamentum Flavum, F) Intervertebral disc
 MCQs: 1) B, 2) C 3) B, 4) B, 5) C, 6) D
 OSCEs: 1) T4 spinal level (nipple line dermatome) 2) Complete spinal cord injury 3) ATLS protocol – Airway with
 cervical spine protection, breathing, circulation, then immobilization. 4) CT spine for fracture, MRI spine for cord
 assessment, 5) Temporary loss of all reflexes and tone below the level of injury. 6) Decompression and
 stabilization surgery + rehabilitation 7) High-dose methylprednisolone (controversial; time-dependent within 8
 hours)