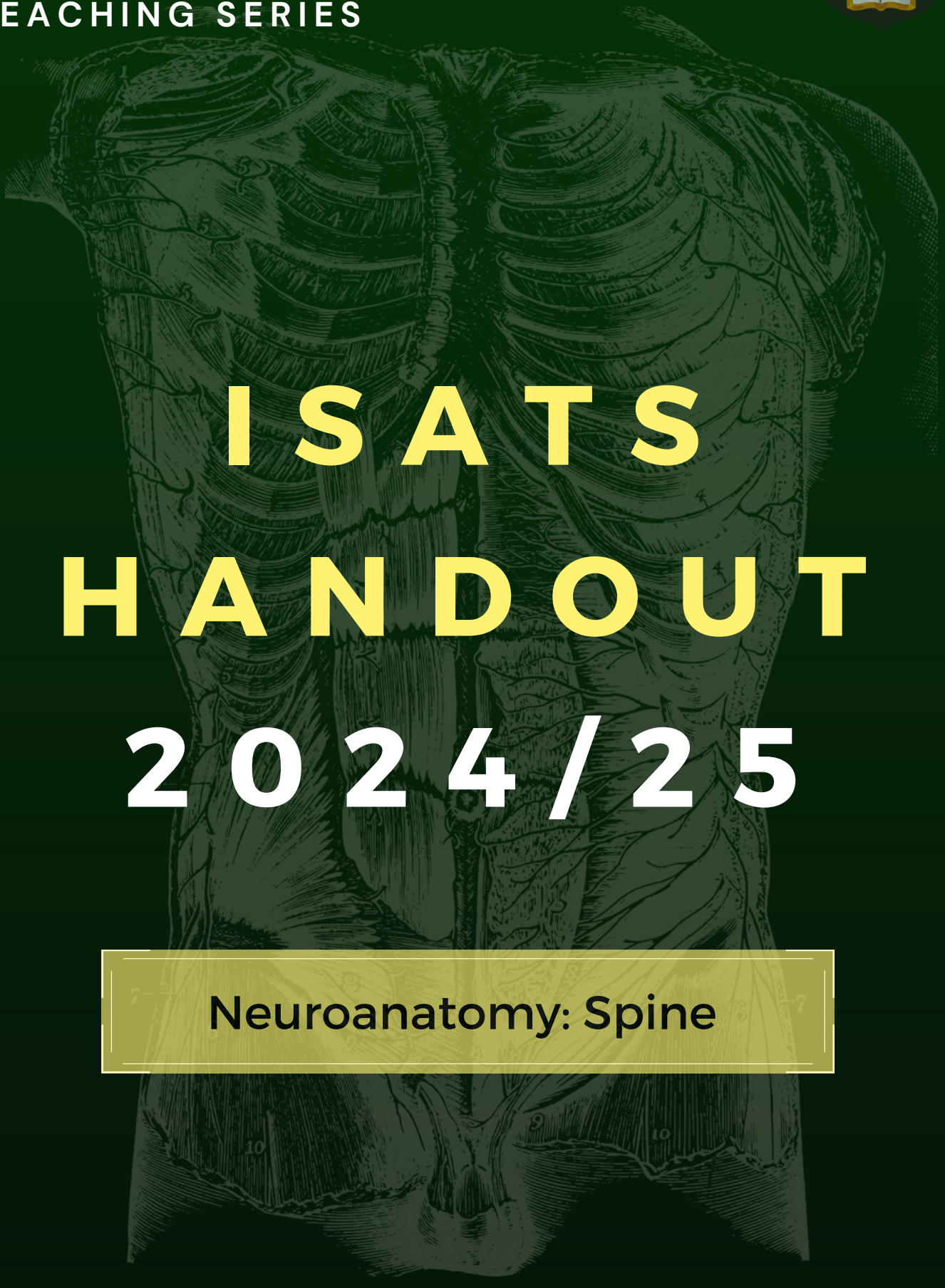
INTERNATIONAL
SURGICAL ANATOMY
TEACHING SERIES



ISATS HANDOUT 2024/25

Neuroanatomy: Spine

High Yield | Surgical Relevance | CPD Accredited

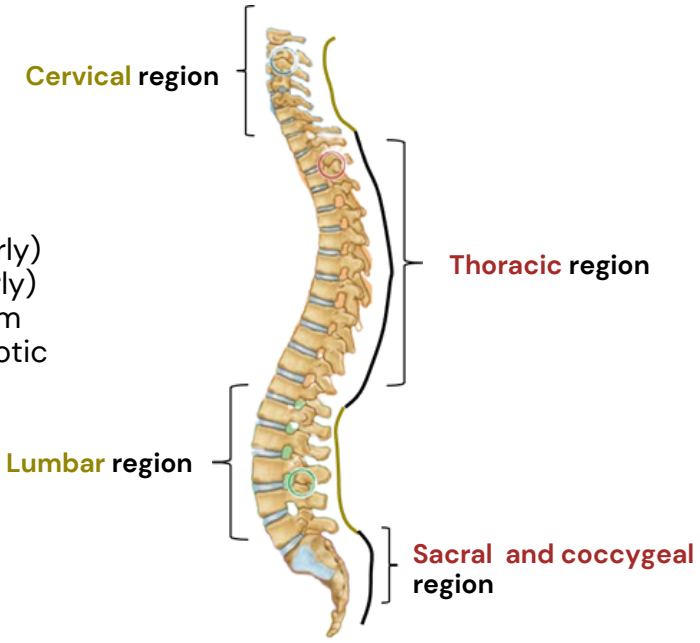
SPINE ANATOMYY

***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

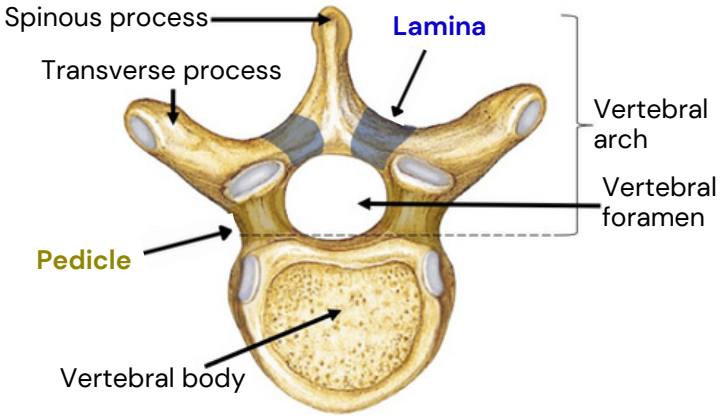
- The spine has two main curvatures:
  - **Kyphotic** - *thoracic and sacral*
  - **Lordotic** - *cervical, lumbar and coccygeal*
- Primary curvatures are kyphotic (concave anteriorly)
- Secondary lordotic curvatures (concave posteriorly) develop from extension of the neck and bipedalism
- Increased 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.

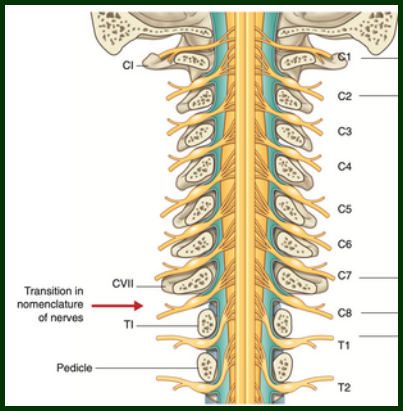
All structures unite to form a hollow, **vertebral foramen** along the spinal column which encloses the spinal cord.



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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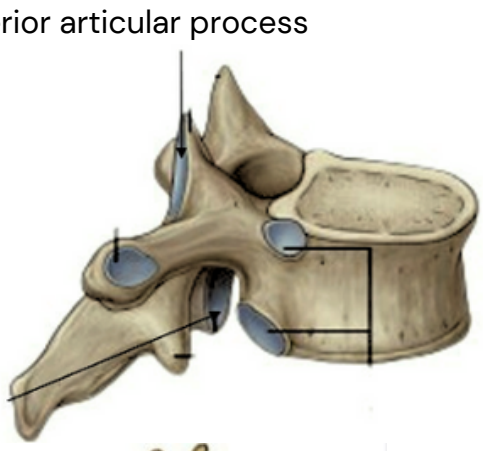
[Continued typical features]

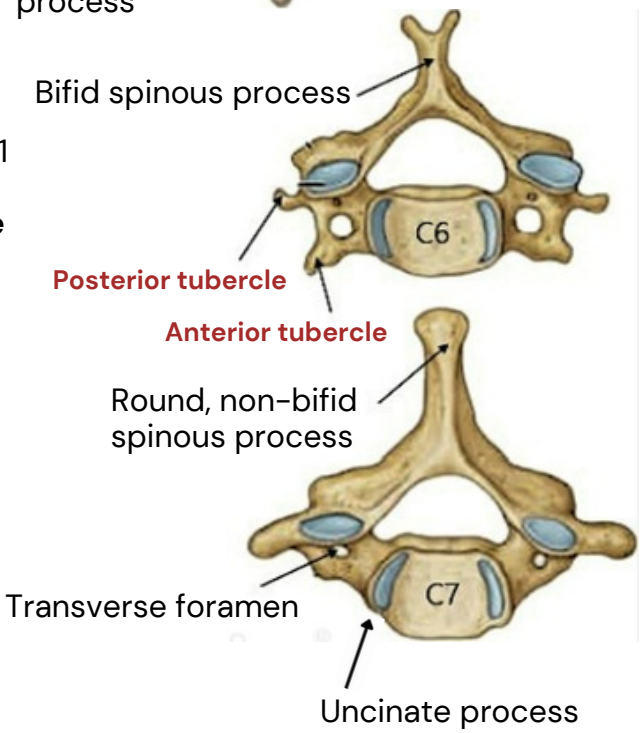
- **Articular process** - located at the intersection between pedicles and lamina.
  - Superior and inferior articular processes join to form zygapophyseal joints [**synovial plane joint**]
  - These joints allow for articulation with adjacent vertebrae



Region-specific unique features

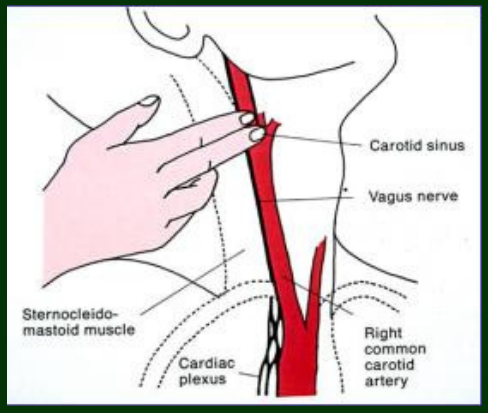
Cervical Vertebrae

- **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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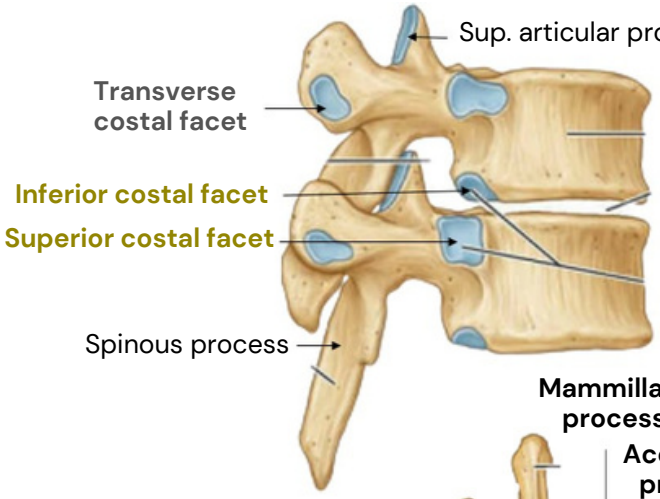
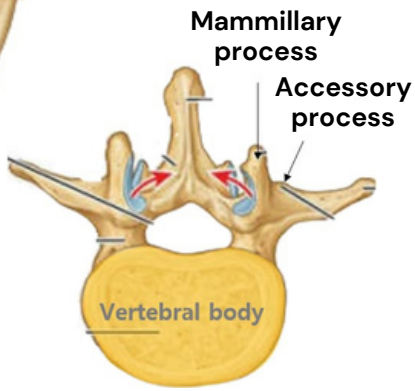
Thoracic Vertebrae

- 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.

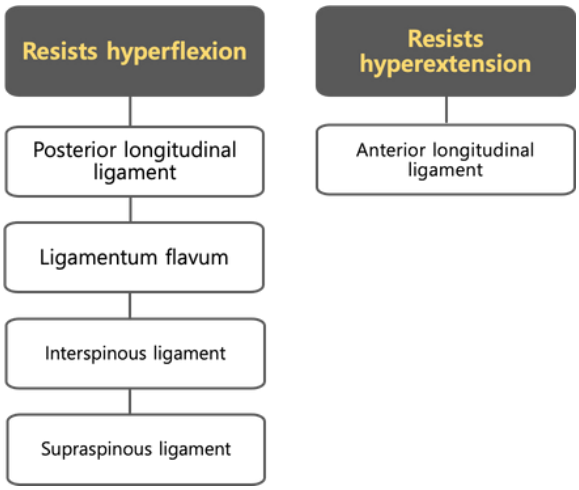


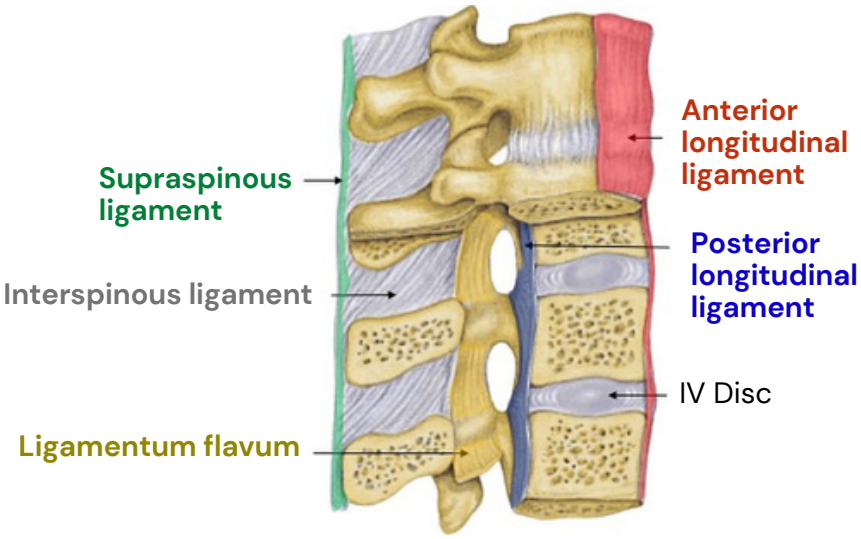
Lumbar Vertebrae

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



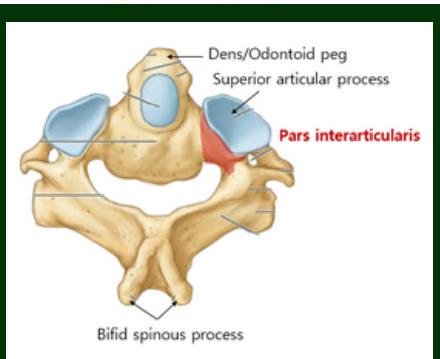
Vertebral Column Ligaments





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 unilatereral 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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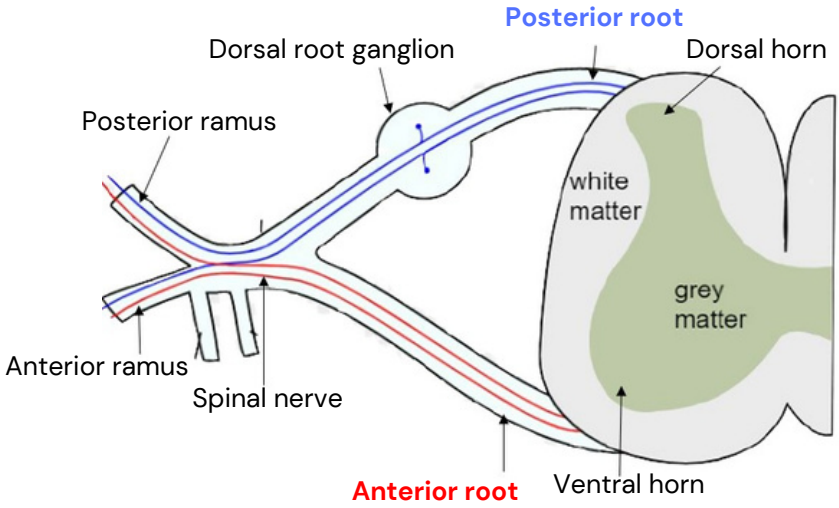
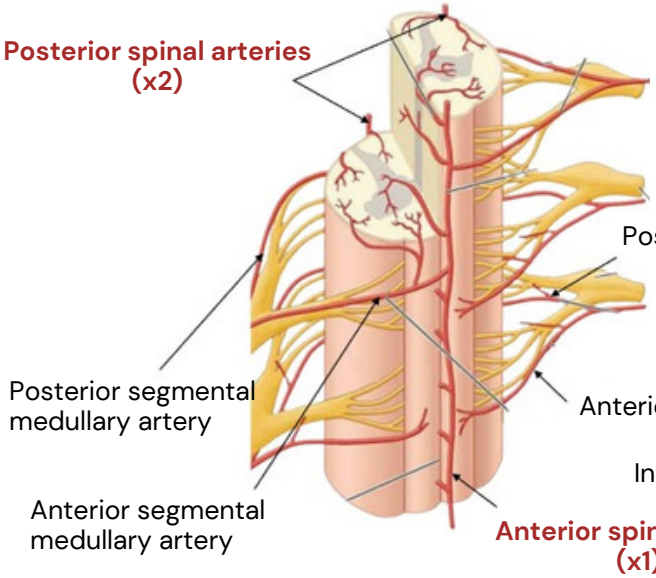
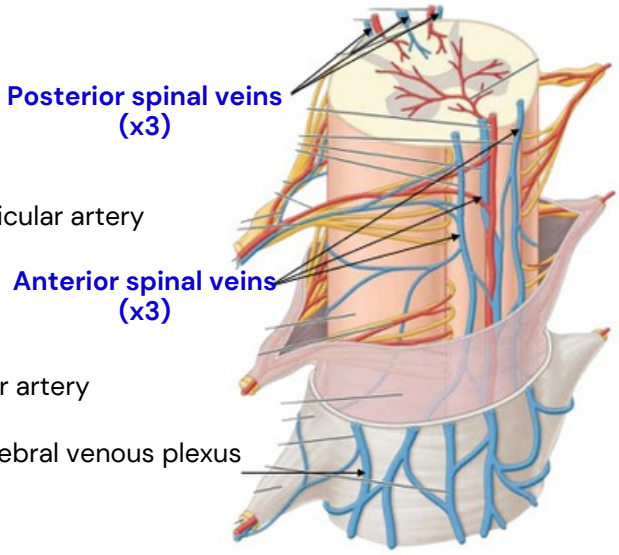
Peripheral nerve pathway

- 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



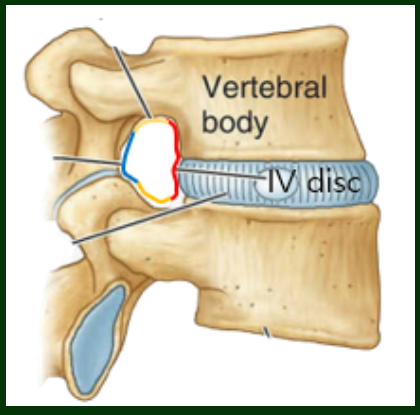
Vascular supply





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



SPINE ANATOMY

Test yourself

1) Label the lumbar vertebra:

1)

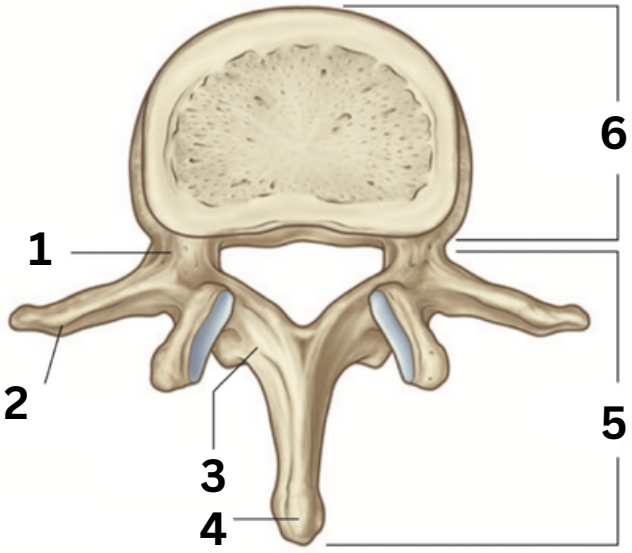
2)

3)

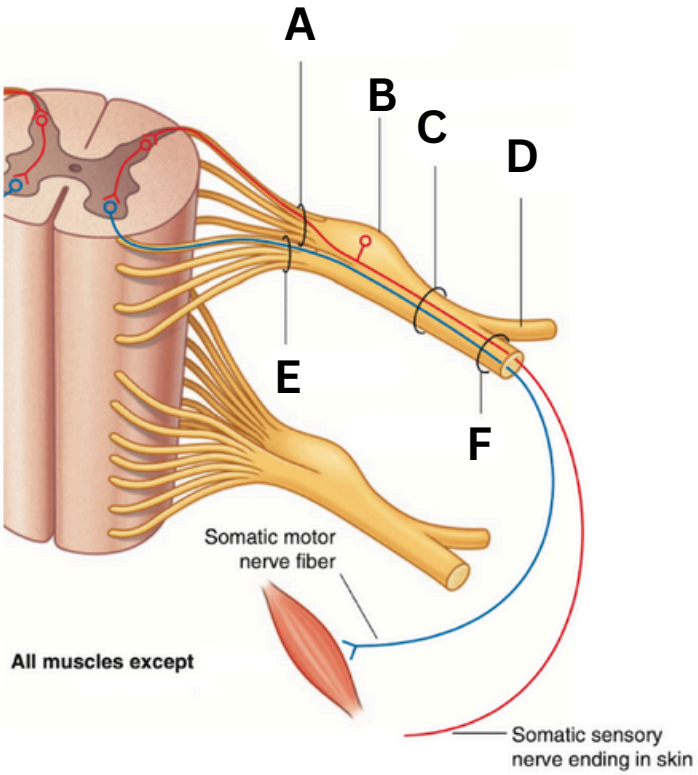
4)

5)

6)



2) Label the spinal cord section:



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

The vertebral arch has several bony prominences. These act as attachment sites for muscle and ligamentous attachments. Which bony prominence does not make up the vertebral arch

A. Uncinate process
B. Pedicles
C. Spinous process
D. Transverse process
E. Superior articular process

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

Cauda equina syndrome is compression of the spinal roots L2 and below. It is a surgical emergency. Which of the following is not a symptom?

A. Bilateral sciatica
B. Saddle anaesthesia
C. Babinski response
D. Decreased anal tone
E. Urinary dysfunction

MCQ 5

A surgeon is preforming an epidural steroid injections. What layers does the needle need to penetrate?

A. Supraspinous ligament, interspinous ligament, PLL,
B. Interspinous ligament, ligamentum flavum, ALL
C. Supraspinous ligament, interspinous ligament, ligamentum flavum
D. ALL, IV disc, PLL
E. ALL, PLL, interspinous ligament

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?

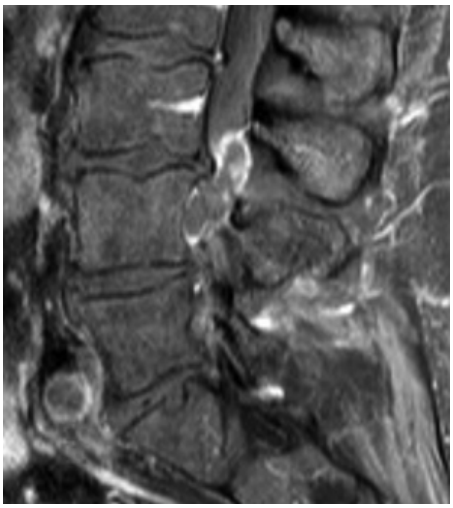
A. L3 nerve root compression
B. L4 nerve root compression
C. L5 nerve root compression
D. S1 nerve root compression
E. S2 nerve root compression

SPINE ANATOMY

Test yourself

OSCE Station - Case Based Discussion

57-year-old male presented to the GP with a 2 week worsening of low back and left leg radicular pain. The following week, he suddenly developed urinary incontinence and weakness in both feet. Neurologic examination showed hypoesthesia on the left L4-5 dermatomes. Weakness was observed in the dorsiflexors of both feet (2/5 left, 1/5 right) and big toe extensors (1/5 right, left 2/5). Myotatic reflexes were absent.



Q1. What further investigations would you like to preform?

Q2. A primary benign spinal tumour is diagnosed, what are possible differentials?

Q3. What is the most common type of primary bone tumour, and what are characteristic x-ray features of this?

Q4. What would be most appropriate surgical treatment for this patient?

Q5. What are the complications of the surgical treatment mentioned in Q4?

Answers
Labels: 1) Pedicle, 2) Transverse process, 3) Lamina, 4) Spinous process, 5) Vertebral arch, 6) Vertebral body
A) Posterior root, B) Spinal ganglion, C) Spinal nerve, D) Posterior ramus, E) Anterior root, F) Anterior ramus
MCQs: **1)** B, **2)** A, **3)** B, **4)** C, **5)** C, **6) D**
OSCEs: 1) Whole spine MRI, fine needle aspiration biopsy, histological analysis. 2) Osteochondroma, Osteoid Osteoma, Osteoblastoma, Giant cell tumour of bone. 3) Osteosarcoma, these are primary malignant bone tumours and are mainly seen in children and adolescents. X-ray shows Codman triangle (from periosteal elevation) and 'sunburst' pattern .4) Surgical resection of the tumour, as these tumours are usually unilateral, the most common procedure was hemilaminectomy of one or several levels depending on the extension of the lesion, followed by removal of the tumour. 5) Spinal nerve injury, worsening neurological deficit, haematoma, infection, CSF leak, permanent bowel and bladder dysfunction,