THE VERTEBRAL COLUMN:

- Axial skeleton:
  - Vertebral column
  - Rib cage
  - Skull

- Vertebral column:
  - Supports skull above
  - Provides anchorage for the ribs
  - Protects the spinal cord.

- Each bone in vertebral column = vertebra
  - 7 cervical vertebra
  - 12 thoracic vertebra
  - 5 lumbar vertebra
  - 5 fused sacral segments (wedged between the 2 sides of the pelvis).
  - Coccyx (4 fused bones)

- Vertebrae are stout – provides the strength needed to support the weight of the trunk
- Esp. stout in lower parts of the column
- Vertebral column held together by strong ligaments and muscles

Infants:
- Vertebral column flexed like a letted ‘C’
- This anterior flexure: **primary curvature**

- During development, 2 secondary curvatures develop in cervical & lumbar regions.
- Both of these secondary curvatures are concave posteriorly.
- **Secondary cervical curvature:**
  - Develops as children begin to hold their head up
  - Due to development of muscular support needed to balance head:
    - Strong extensor muscles in back of neck needed to counter tendency for head to fall forward onto chest.
- **Secondary lumbar curvature:**
  - Develops as children learn to walk upright & balance on 2 feet.

- **Lardosis** is an increased *anterior convexity* of vertebral column – especially common in the lumbar region.

- **Kyphosis** is a *posterior convexity* of the vertebral column

- **Scoliosis** is a *lateral curvature & rotational deformity*
  - Scoliosis often occurs together with lardosis / kyphosis
THORACIC VERTEBRAE:
- Vertebrae differ in shape from region to region, but there is a basic pattern
- Each vertebra consists of 2 main parts:
  - Body
  - Vertebral arch
- Body and arch together enclose a hole – the *vertebral foramen*
- 3 boney processes arise from the *vertebral arch*:
  - Spinous process
    - Projects backwards & downwards from middle of vertebral arch
  - R & L transverse processes
- Transverse processes divide the vertebral arch into 2 parts:
  - Pedicle lies between the body and the transverse process
  - Lamina lies between the transverse process and the spinous process
- The laminae bear the spinous process
• Each thoracic vertebra articulates with a pair of ribs
• Vertebrae in the cervical & lumbar segments also have a ‘costal element’ which represents an undeveloped rib.
• Sometimes these elements are well developed – cervical / lumbar ribs
• On lateral surface of all thoracic vertebrae (except T1, T11 & T12), there are hemifacets at the top and bottom for articulation with the ribs.
• Each rib articulates with vertebrae of its own number, and the vertebra above
• Δ head of rib straddles the intervertebral disc between the 2 vertebral bodies.
• Ribs T1, T11 & T12 articulate only with the thoracic vertebra of their own number.
• The ribs also articulate with the transverse processes of the vertebra at a different synovial joint.

• 12 thoracic vertebra sit one on top of the other → the vertebral foramina from a continuous tube – vertebral canal
• The vertebral canal contains the spinal cord
• Between each vertebra, there is an exit on the right and left sides from the vertebral canal.
• These are called intervertebral foramina
• The intervertebral foramina are bounded:
  o Anteriorly: **vertebral body + intervertebral disk**
  o Above & below: **pedicles**
  o Posteriorly: **synovial facet joints between vertebral arches of adjacent vertebra.**

• The intervertebral foramina allow several structures to pass out:
  o Nerves
  o Arteries
  o Veins

• Vertebra are joined together by means of joints & ligaments

• **2 articulations between any 2 vertebra:**
  o Body – body (IVD)
  o Vertebral arch – vertebral arch (facet joint)

**Body-body joint:**
• **Secondary cartilaginous joint**
• Called the **intervertebral disc**
• Covering the surface of each vertebral body in the region of the intervertebral disc is a **thin layer of articular cartilage.**
• vertebral body – hyaline cartilage – intervertebral disc – hyaline cartilage – vertebral body
• Strong fibrous cartilage unites these layers of cartilage
• Can withstand strains in any direction
• The fibrous tissue only exists around the periphery of the disc – **annulus fibrosus**
• The center of the disk is not fibrous – it is a **gelatinous ball** called the **nucleus pulposus**
• The body of the vertebra can move around the nucleus pulposus mass in any direction
• If the annulus fibrosus and nucleus pulposus was only articulation between the two discs, the column would be freely moveable in all directions.

• The annulus fibrosis can sometimes degenerate posteriorly
• Nucleus pulposus can then herniate through the posterior aspect of the body, into the intervertebral foramen
• Spinal cord or spinal nerve may be compressed
• **Herniated intervertebral disc (“slipped disc”)**
Vertebral bodies are held together by longitudinal ligaments as well as the intervertebral disk.

**Anterior longitudinal ligament:**
- Extends from cervical region → sacrum
- Unites the anterior surfaces of the vertebral bodies
- Not attached to the intervertebral discs

**Posterior longitudinal ligament:**
- Extends from vertebra to vertebra in the vertebral canal behind the bodies
- Attached to each intervertebral disk
- Narrows over each body

**Vertebral arch – vertebral arch joint:**
- **Zygapophysial joint / facet joint**
- Vertebral arches articulate with one another by means of synovial joints
- Each vertebral arch has 4 articular facets:
  - 2 for articulation with the vertebra above
  - 2 for articulartion with the vertebra below
- The plane at which the articular facets are set depends on the level of the vertebra.
- The plane of movement of these joints limits the otherwise universal movement permitted by the body-body articulation.

- In the **thoracic region** the facets lie at the arc of a circle
- Centre of the circle is usually at the nucleus pulposus
- Flexion is limited
- Articular facets allow mostly a rotational movement, but even this is not great, since the ribs also limit movement between thoracic vertebra.

- Several ligaments also attach the vertebral arches together:

- **Ligamenta flava** are yellow elastic ligaments that bind adjacent laminae together

- **Supraspinous & interspinous ligaments** bind the spinous processes together
  - Supraspinous: binds the tips of the spinous processes
  - Interspinous: binds the bodies of the spinous processes together
- **Intertransverse ligaments** bind the transverse processes together

*Thoracic vertebrae on a radiograph:*
- Not easy to see the thoracic vertebrae on a radiograph as they are largely obscured by the ribs
- Radiographs are usually either:
  - Lateral
  - Or anteroposterior
- A lateral view shows clearly the *intervertebral foramen* (seen more clearly if view is slightly oblique).
CERVICAL VERTEBRAE:
- Smaller and more delicate than thoracic vertebrae
- 7 cervical vertebrae
- First and second are important and have special names:
  - C1: atlas
  - C2: axis
- Atlas + axis are important in supporting the skull and allowing movements:
  - Atlas: nodding of head
  - Axis: rotation of head

Typical cervical vertebra (C3-C7)
- Bodies:
  - Small & delicate
  - Oval shaped
- Bodies are joined together by intervertebral disks
- Intervertebral joints are strengthened by:
  - Anterior longitudinal ligament
  - Posterior longitudinal ligament
- Vertebral foramen:
  - Triangular in shape
  - Very large, as the spinal cord is largest at this level
- Body of cervical vertebra have small upturned lips on upper lateral margins
- Each lip is called an uncus (aka ucinate process)
- The uncus and body of next vertebra are joined by uncovertebral joints
- Uncovertebral joints:
  - Found only between cervical vertebrae
  - Associated with rotational movements of cervical column

Transverse process
- The transverse processes of all cervical vertebrae have a hole in them – foramen transversarium
- The foramen transversarium of the cervical vertebrae lie one on top of the other – creating 2 tunnels.
- A vertebral artery runs up through these foramen transversarium
- The vertebral artery is a branch of the subclavian artery on each side.
- The right & left vertebral arteries enter the foramina transversaria of C6
- Enters the brain through foramen magnum:
  - Supplies brain & spinal cord with blood
- Transverse process has:
  - Anterior tubercle
  - Posterior tubercle
- These tubercles give rise to muscles of the neck (middle layer muscles):
  - Scalenus anterior
  - Scalenus medius
  - Scalenus posterior
- Only the posterior tubercle belongs developmentally to the transverse process
- The anterior tubercle is a degenerated cervical rib and is a costal element
- Sometimes the anterior tubercle of C7 is large – can form a complete 'cervical rib'
Clinical complications of a cervical rib:
- Impede bloodflow into subclavian vessels
- Stretch lower nerve roots of brachial plexus (esp. T1 – medial cord [ulnar]) → weakness in small muscles of hand.

Spinous process:
- The spinous processes of the cervical vertebrae are bifid
- All of the processes of the cervical vertebrae are united by ligaments:
  - Supraspinous ligament
  - Interspinous ligament
  - Intertransverse ligament
- Like the thoracic vertebrae, the cervical vertebral arches are joined together by synovial joints
- The facets for these synovial joints do not lie on the arc of a circle as in the thoracic region
- Δ allow little rotation between individual typical cervical vertebrae (C3-C7)
- Instead lie on a coronal plane (vertical)
- Δ allows:
  - Lateral flexion
  - Flexion
  - Extension

The laminae are united by ligamenta flava
• **C7** is the most prominent of the cervical vertebrae
  *(Note: the uppermost thoracic vertebrae may be more prominent)*
• Spinous process of C7 can easily be palpated in the neck
• Δ C7 vertebra is called **vertebra prominens**
• Use vertebra prominents to count down the other vertebrae.

**Atlas (C1) & Axis (C2)**

• **Atlas** has **no body**
• Simply a ring of bone comprising of:
  - **Anterior arch**
  - **Posterior arch**
• The two arches are united on either side by two **lateral masses**
• Lateral masses made up of:
  - Transverse processes
  - Articular facets
• Why is atlas like this?
  - **Supports the skull**
  - Allows for **nodding movement** – between superior articular facets and **occipital condyles** of the skull

• **Axis** does have a body
• On top of the body sits a peg of bone – **dens / odontoid process**
• Dens is said to be the body of the **atlas** which has become attached to the **axis**
• The dens projects into socket within the ring of the atlas – allows rotation of the atlas & head around the dens.

• Both atlas and axis have **foramen transversarium** in their transverse processes.
• The vertebral arteries pass through these.
• Having reached the foramen transversarium of the atlas, the vertebral artery curves back over the lateral mass of the atlas and its posterior arch
• → enters the vertebral canal & foramen magnum

**Articular surfaces of the atlas & axis:**

**Superior articular facet of atlas – occipital condyles of skull**

• **Atlas**: the **superior articular facet** of the atlas is:
  - Concave
  - Kidney shaped
• Each superior articular facet accepts an occipital condyle at the base of the skull
• This is a **synovial joint**
• Allows the 2 facets to slide against each other.
• Allow only nodding movement of the head:
  - Flexion
  - Extension
• **Slight** degree of side-to-side rocking is also possible.
• **No** rotation is possible at this joint
Superior articular facets of axis – inferior articular facets of atlas
- Articulation between atlas and axis.
- **Axis**: the superior articular facets of the axis lie either side of the base of the dens
- Articulate with the inferior facets of the atlas
- **Synovial joints**
  - Allow only rotation of atlas ring on the axis around the dens.
  - The articular surfaces must be flat in order to allow this.
- Strong ligaments stabilise these joints
- Dens is inserted into a socket formed by:
  - Anterior arch of atlas
  - **Transverse ligament**
- This is a synovial peg & socket joint – allows rotation
- **Transverse ligament** is continuous upwards and downwards, as a second layer of support.
  - Upper continuation:
    - Attach to the skull
    - Hides 3 short ligaments (see below)
  - Lower continuation:
    - Attached to the body of the axis
- **3 ligaments**: connect...
  - dens → interior of the base of skull
- The transverse ligament + 3 ligaments to the base of skull = cruciate ligament
- On the posterior surface of the cruciate ligaments, the posterior longitudinal ligament continues
- It continues up into the base of the skull as a third layer of support
- In the region of the skull the posterior longitudinal ligament is known as the membrana tectoria
Summary:
- Atlas is sandwiched between the skull and the axis
- Ligaments act to stabilise each of the articulations between these 3 bones:
  - Cruciate ligament:
    - Transverse ligament
    - 3 ligaments from the dens (alar x 2, apical)
  - Posterior longitudinal ligament → membrana tectoria
- Radiographs of atlas and axis are best taken through an open mouth, with plate positioned at back of head & neck.

LUMBAR VERTEBRAE:
- 5 lumbar vertebrae
- More massive and stronger than C / T vertebrae
- Short strong processes
- Kidney shaped bodies
- Small vertebral canal
- Bodies are united by intervertebral disks
- Degeneration & herniation of the intervertebral disks is most common between:
  - T12-L1
  - L4-L5
  - L5-S1
• The vertebral arches of the lumbar vertebrae bear strong transverse & spinous processes

**Spinous processes:**
  - Not as long as those in the thoracic region
  - Project directly backwards
  - (in the thoracic region they protrude downwards & backwards)

**Transverse process:**
  - Is a *costal element*
  - The true morphological transverse element is a small mass of bone at the base
  - The costal ‘transverse process’ of L1 can sometimes be separate, and is united to the body of L1 by a synovial joint – **lumbar rib**
  - Lumbar rib is much rarer than a cervical rib.

• **Ligaments** uniting arches & processes in the lumbar region are thick & strong.

• Articular facets form synovial joints between the arches
• These joints are aligned in the sagittal plane, allowing:
  - Flexion
  - Extension
  - Some lateral flexion
  - NO rotation

• Intervertebral foramina of the lumbar region are bounded by:
  - Anteriorly: body + intervertebral disk
  - Above & below: pedicles
  - Behind: synovial joint between superior and inferior articular facets (facet joint)

• Region of lumbar vertebrae between superior and inferior articular facets (of a single vertebra) is known as **pars interarticularis**.

• Traumatic fractures across the pars interarticularis
• On an *oblique* radiograph of the lumbar region, the pars interarticularis looks like a ‘scottie dog’
  - Nose: transverse process
  - Eye: pedicle
  - *Ear*: superior articular process
  - *Neck & collar*: pars interarticularis (between superior & inferior articular facets)
• A pars which is *radiolucent* (transparent) is either fractured or cartilaginous

• **Spondylolisthesis** *slippage of the vertebral body*
  • Often anterior displacement of the vertebra above with respects to the one below
  • Due to either:
    A. Failure of fusion of vertebral arch with the body during ossification.
      • Both collars of the ‘scottie dog’ have failed to fuse
    B. **Bilateral fracture of both pars iterarticularis**
      • On radiograph, body appears to have slipped a little on the sacrum.

**SACRUM AND COOCYX:**
• Sacrum consists of 5 vertebrae, fused to form a boney mass
• Triangular in outline
• Upper surface of sacrum articulates with L5:
  • Intervertebral disk between vertebral bodies
  • Synovial joints between articular facets

  • On either side the sacrum articulates with the pelvis – but the body weight does not pass through these *joints*.
  • Instead the body weight passes through strong ligaments – *sacroiliac ligaments* – which join the sacrum to the pelvic ileum.

• Sacrum is concave anteriorly
• First sacral mass bulges into the pelvic cavity – forms the *promontory of the sacrum*
• On the midline posteriorly, the fused vertebrae can be outlined by 4 transverse ridges of bone
• These boney ridges represent the ossified intervertebral discs of the sacral region

• On either side of the midline are 4 anterior sacral foramina
• Sacral ventral rami pass through these foramina

• On the lateral sides of the foramina are 2 massive lateral masses (ala) of bone
• The lateral masses + the bone between them and the foramina, represent the costal elements of the sacral vertebrae.

**Posterior surface**
• Posterior surface of the coccyx is convex
• In the midline posteriorly – median crest – represents the fused spinous processes.
• In the midline below the median crest (posteriorly), the vertebral canal opens out at the sacral hiatus
• The sacral hiatus is such because the posterior part of the vertebral arch at this level remains deficient throughout life.
• In life the hiatus is closed with a little loose fibrous tissue

• Lateral to the midline crest on either side is the articular crest
• Articular crest represents the fused articular processes of the sacral vertebrae.

• **4 posterior sacral foramina** transmit the dorsal rami
• 5th sacral foramina is formed on either side of the sacral hiatus.
  o From the 5th foramina arise the:
    ▪ Small 5th sacral nerve
    ▪ Coccygeal nerves
• Lateral to the posterior foramina is a lateral crest representing the fused transverse processes of the sacral vertebrae.
Sex differences between the male & female sacrum:
- Comparison of with of body and ala of the S1 segment:
  - Women have wider sacral alae (lateral masses) such that the vertebral body makes up less of the width of the sacrum.
  - In women the sacrum as a whole is wider, but the bodies of the sacral vertebrae are narrower.
- Local anaesthetic can be introduced to the extra-dural space by passing a needle into the region of the sacral hiatus.
- Anaesthesia of lower sacral & coccygeal nerves is useful in obstetric procedures on the vagina.
- COCCYX is all that is left of the tail
  - 4 fused bones
  - Joined to apex of sacrum:
    - intervertebral disk
    - Two small lateral synovial joints
CONTENTS OF THE VERTEBRAL CANAL:

- Vertebral canal = smooth-walled tube in which spinal cord lies
- Vertebral canal is lined:
  - In front by the **posterior longitudinal ligament** – covering the vertebral bodies & disks.
  - Behind by the **ligamentum flavum** – joining adjacent laminae
- Above the canal is continuous with the cranial cavity
- Spinal cord is continuous with the brain at this level.

- Below the canal opens at the small sacral hiatus

- At each intervertebral level, the **intervertebral foramina** give openings in the vertebral canal.
LP layers:
- Skin
- Subcut fat
- Supraspinous ligament
- Interspinous ligament
- Ligamentum flava
- Extradural space (fat + internal vertebral venous plexus)
- Dura
- Arachnoid
  ... Subarachnoid space with CSF

Inside the vertebral canal:

1. **Extradural fat:** Layer of loose fat is the first thing encountered on opening the vertebral canal
   - The vertebral & spinal veins + arteries pass through this loose fat.
   - Contains a rich plexus of veins
     - This plexus of veins runs the length of the canal as the **internal vertebral venous plexus**.

2. **Membranous covering (meninges)** of spinal cord lies deep to the loose fat
3. **Spinal cord**

![Diagram of Spinal Cord](image1)

**Venous drainage of spinal column**

![Diagram of Venous Drainage](image2)
- Blood drains → **internal vertebral venous plexus** (in extradural space) from both:
  - Spinal cord
  - Vertebral bodies
- Vertebral body of each vertebra contains erythropoietic bone marrow
- Α must have good venous drainage to take newly formed RBCs to the circulation.
- Usually 2 **basivertebral veins** leaving each vertebral body
- These veins are valveless – blood can move through them in any direction

- Internal vertebral venous plexus drains through the intervertebral foramen → **external vertebral venous plexus**.
- The **external** vertebral venous plexus surrounds the entire vertebral column.
- Lies mainly in the muscles masses at the back and front of the column.

- Eventually the **external vertebral venous plexus** drains → **segmental veins of body wall**:
  - Thoracic level: **posterior intercostal veins**
  - Abdomen: **lumbar veins**
- Because the vertebral venous plexuses are **valveless** → **easy reverse flow**.
- Reverse flow esp. common when intra-abdominal pressure is ↑:
  - Coughing
  - Sneezing
  - Childbirth
  - Lifting heavy loads
- Blood is momentarily diverted to the venous plexus → ↑pressure in the vertebral column.
- Then returns to normal route:
  - Internal vertebral VP → external vertebral VP → posterior intercostal / lumbar → SVC/IVC
- Retrograde venous flow allows easy spread of cancer cells, and so metastases in the **vertebral bodies** is not uncommon.

*Arterial blood supply to spinal cord:*
• Arterial blood supply to the spinal cord comes mainly from above
• At level of foramen magnum, arteries arise from the vertebral artery:
  o An anterior spinal artery
  o 2 posterior spinal arteries
• The anterior spinal artery descends along midline groove on the anterior surface of spinal cord
• The 2 posterior arteries pass down the posterior surface of the cord.

• At each spinal level the blood supply is reinforced by segmental spinal arteries (radicular arteries).
• Enter the vertebral canal through the intervertebral foramen
• These segmental spinal arteries are branches of the segmental arteries of the body wall:
  o Thoracic intercostal arteries
    ▪ Small except for the 1st & 11th thoracic segments
THE MENINGES:
- Removal of extradural fat & internal vertebral venous plexus – allows good view of membranous covering of spinal cord.
- Both the brain & spinal cord are covered with a continuous, 3-layered protective sheath
- This sheath is called the **meninges**
  - Inner layer: **pia mater**
  - Middle layer: **arachnoid mater**
  - Outer layer: **dura mater**
- **Pia mater** is the innermost layer of the meninges.
- Delicate layer
- Closely applied to the neuro-axis
  - Dips into the fissures and indentations of the brain and spinal cord
- Many small blood vessels may run within the pia mater on their way to supply nervous tissue.
- **Arachnoid mater** is the middle layer
- It does not closely invest the brain or spinal cord
- Δ creates a space between the arachnoid & pia layers.
- This is called the **subarachnoid space**
- The subarachnoid space contains **CSF (cerebrospinal fluid)**
- The CSF acts as a buffer & a shock absorber – **protects the NS from trauma**
- CSF is produced in the cavities of the brain
- The CSF circulates in the subaracnoid space surrounding both the brain and the spinal cord
• CSF absorbed into the venous blood via **arachnoid granulations** found in the **venous sinuses of the cranial cavity**.

• There is a circulation of CSF:
  - Production in cavities of brain
  - Circulation through subarachnoid space
  - Absorption into venous blood of cranial cavity via arachnoid granulations

• The arachnoid mater sends **fine web-like processes** through the CSF to attach to the **pia mater**.

• In some parts of the skull & vertebral canal the **subarachnoid space is enlarged** → **pools of CSF**.

• These pools of CSF are called **cisterns**.

• **Dura mater** is the outermost layer of the meninges.
  - There is only a **capillary interval** between the arachnoid mater & the dura mater – the **subdural space**.
  - The dura mater is **thick, fibrous & strong**.
  - The **dura mater of the brain is directly continuous with that of the spinal cord**.

• In certain places in the skull, the dura meter is fused to the periosteum of the bone.

• In other places there is gap between the dura mater and the periosteum.
  - These gaps are filled with venous blood.
  - Called **cranial venous sinuses**

• **NOTE** both cranial venous sinuses & internal vertebral venous plexuses lie within the **extradural space** (i.e. outside the dura mater).

• In the vertebral canal, the dura forms a kind of **tube**.
  - Dura is not fused to the periosteum of the vertebra, but is seperated from the walls of the canal by extradural fat & internal vertebral venous plexus.
  - Space between the dura & boney walls is the **extradural space**.

• The dura is **drawn out along the spinal nerves** through the intervertebral foramina.
  - The dura attaches to the **intervertebral foramina** – stabilising the dural tube within the vertebral canal.
• The spinal cord is protected by the meninges and the CSF
• Small processes of the pia mater arise from either side of the spinal cord
• **Arise between dorsal & ventral roots.**
• Pass through the CSF → pierce the arachnoid → attach to the dura
• Called the **ligamenta denticulata**
• **Suspend the cord from the dura in the CSF**
• **Lowest** ligamentum denticulata is at **L1**

**Spinal cord:**
- 18 inches long (in adult)
- Doesn’t extend to the end of the vertebral canal
- Reaches to lower border of **L2**
- **At birth** the cord extends much lower, but as the vertebral column grows at a faster rate, it draws away from the cord.
- Δ in adults the spinal nerves need to run further to reach the intervertebral foramina (esp. for lower lumber & sacral roots).

**Arrangement of cord & meninges at lower vertebral column:**
- Spinal cord + pia mater end at lower border of **L2**
- The terminal end of the spinal cord is called the **conus medullaris**
- BUT thin strand of the pia – **filum terminale** – continues down through the subarachnoid space → sacral part of canal.
- The filum terminale pierces the dura and attaches to the **Coccyx 2**
- The role of the filum terminale is similar to that of the ligamentum denticulatum – helps suspend the cord in the CFS.

- The dura & arachnoid do not end with the cord & pia
- The dura & arachnoid continue down to the level of **S2**
- Δ large subarachnoid space in the region between L2-S2 called **lumbar cistern**
- Roots of lumbar & sacral nerves run through this cistern – **cauda equina**

**Applied Anatomy of the Vertebral Canal:**

**Lumbar puncture**
- The **lumbar cistern** is a convenient place to remove a sample of CSF for **clinical analysis**
- The procedure is a **lumbar puncture**
- Patients back is marked with 2 lines:
  - Vertical: in the midline
  - Horizontal: joins the two iliac crests
- Where the lines cross in the midline is **L4**
- Sterile needle is introduced between **L4-L5** under local anaesthetic.
- Needle passes through:
supraspinous & interspinous ligaments
- ligamentum flavum
- extradural fat
- dura mater
- arachnoid mater
- subarachnoid space (containing CSF)

- This level is well below the termination of the spinal cord (at L2) so can safely introduce needle into the subarachnoid space.
- CSF is aspirated.
- Do not damage the nerve roots as they float away from the needle in the CSF.

- Can also use lumbar puncture to measure the pressure of CSF.
- Normally 60-200mm of CSF
- Coughing/sneezing → ↑ pressure of CSF due to retrograde blood flow through internal vertebral venous plexus.

- Can also use lumbar puncture to introduce radio-opaque dye to the subarachnoid space
- Allows tumours of the cord to be investigated by radiography.
- Called myelography.

“Slipped discs”
- Degeneration & herniation of the intervertebral disks is most common between:
  - T12-L1
  - L4-L5
  - L5-S1
- Nucleus pulposus can herniate through the tough annulus fibrosis, exerting pressure on the nerve roots of L5 & S1
- Can lead to:
  - Pain in lower limb
  - Sensory loss in lower limb
  - Wasting of leg muscles
• ‘Slipped disc’ & ‘sciatica’ are extremely common complaints.
• Sciatica results from compression of one of the nerve roots of the sciatic nerve (L4-S3)

**MUSCULATURE OF THE VERTEBRAL COLUMN:**
• Vertebral column is surrounded by muscles
• Thick & strong muscles in some places
• Weak / absent in others
• Musculature of body wall has 3 layers – but during development muscles of these different layers may migrate to serve different functions.
  o **Internal layer** – lies inside the ribs / costal element of the vertebrae
  o **Middle layer** – lies between the ribs / costal elements
  o **Outer layer** – lies outside the ribs / costal elements

**Inner layer muscles:**
• **Prevertebral muscles** – in cervical and thoracic regions
• **Psoas major**
  • These muscles arise from & insert into the vertebral bodies & discs
  • Innervated by ventral rami of appropriate spinal segment.
  • Allows **flexion** of the vertebral column.

**Middle layer muscles:**
• **Scalene muscles** – in neck
  o Origin: arise in part from anterior tubercles of cervical vertebrae transverse processes
    (i.e. the costal elements)
  o Insertion: first 2 ribs
• **Quadratus lumborum** – in lumbar region
  o Origin: ileum
  o Insertion: transverse process of lumbar vertebrae + 12th rib
  o Allows **lateral flexion** of the vertebral column
**Outer layer of muscles:**

- **Erector spinae mass**
  - Consists of several different muscles
  - Strong
  - Extends from sacrum \(\rightarrow\) base of skull
  - Only muscles in the body supplied by the *dorsal rami* of the spinal nerves

- Fibres of erector spinae are frequently involved in back problems
- Erector spinae mass is divided into 3 main groups:
  - **Sacrospinalis** - superficial
  - **Transverse spinalis** – middle
  - **Rotatores** - deep

**Sacrospinalis:**
- Consists of 3 muscle sets which extend from the sacrum \(\rightarrow\) the skull
- Lie vertically
- At lowermost part, the muscle arises from the back of the sacrum – covered with a strong aponeurosis.

**Transverse spinalis:**
- Also consists of 3 sets of muscles
- The 3 groups lie one on top of the other in the groove between the spinous & transverse processes of the vertebrae.
- Arise laterally from parts of transverse processes
- Insert medially into the midline spinous processes.

**Rotatores:**
- Run entire length of the column in short spans between each adjacent vertebra.

- **All the muscles of the erector spinae mass are together known as the *intrinsic muscles of the back***
  - The erector spinae mass **extends** the vertebral column
  - Extension movements are most marked in the lumbar & cervical regions

- **Smaller, deeper muscles** of the erector spinae muscle mass are able to make **fine adjusting movements** – including rotation of one vertebra on another

- **Flexion** of the vertebral column is brought about by **prevertebral & psoas muscle**

- **Lateral flexion** is brought about by the **quadratus lumborum muscle (+scalene muscles)**

**MUSCLES OF THE BACK 1**

Arranged in three layers with three muscles on each layer
All supplied by posterior primary rami

Divided up as follows:

**SUPERFICIAL LAYER**
- Iliocostalis (ILC)
- Longissimus (LG)
- Spinalis (SP)

**INTERMEDIATE LAYER**
- Levator costarum (LC)
- Semispinalis (SS)
- Multifidus (M)

**DEEP LAYER**
- Interspinalis (IS)
- Interttransversalis (IT)
- Rotatores (R)

- **Intertransversalis** (between transverse processes)
- **Interspinalis** (Between spines)
MUSCLES OF THE BACK 2

**Spinalis**
(small, indefinite between spines)

**Iliocostalis**
(mostly lateral, all levels, angles of last 6 ribs to: lumbosacral spines transverse processes above & below posterior tubercles in cervical region)

**Longissimus**
(Medial, thoracic, cervicis & capitis. From thoracolumbar fascia & lumbar transverse processes to several transverse processes above & mastoid process)

**Semispinalis Capitis**
(Transverse processes C5-7, T1-6 to occiput)

**Cervicis**
(On multifidus, lower thorax to skull, transverse processes to spinal processes 6 above)

**Thoracis**

**Levator costarum**
(12 slips from transverse processes C7-T11 to posterior angle of rib below)

**Multifidus**
(lamina to spinous process 2-3 above, from sacrum to C2)

**SUPERFICIAL LAYER**
ILIOCOSTALIS (ILC)
LONGISSIMUS (LG)
SPINALIS (SP)
= ERECTOR SPINAES

**INTERMEDIATE LAYER**
LEVATOR COSTARUM (LC)
SEMISPINALIS (SS)
MULTIFIDUS (M)
= TRANSVERSOSPINALES
Sacrosplanis

Transverse spinalis

Rotatores