VERTEBRAL COLUMN - FEATURES & CURVATURES

VERTEBRAE
7 cervical (atlas, axis & C7 are atypical)
12 thoracic
5 lumbar
5 sacral (fused)
4 coccygeal (3-5)

FUNCTIONS
Weight bearing
Movement of trunk
Support for limbs
Protection of spinal cord
Production of blood
Metabolic reserves (Calcium, etc)

WEIGHT BEARING
Aided by secondary lordosis
  40% bony wedge
  60% disc wedge
Caused/held by
  Extensor spinal muscles
Aided by intervertebral discs
  Dampeners, resilient, compressible

Primary curvature

Neck & lumbar secondary curvatures
INTERVERTEBRAL DISCS & COSTAL ELEMENTS

Intervertebral joints are secondary cartilaginous (symphysis)

Bone ↔ Hyaline cartilage ↔ Fibro-cartilage ↔ Hyaline cartilage ↔ Bone

- Anterior longitudinal ligament
- Posterior longitudinal ligament
- Nucleus pulposus
- Hyaline cartilage
- Annulus fibrosus
  - Alternate angled lamellae
  - Strong attachment to anterior & posterior longitudinal ligaments
  - Fibrocartilage

• 15% of disc
• Gelatinous, occasional cells
• 90% water normally
• 70% in old age
• Increasing collagen with age
• Decreasing elasticity with age
• Notochord remnant
• Towards back in lumbar region
• Herniation damages nerve one below the level of prolapse

COSTAL ELEMENTS OF VERTEBRAE AT VARIOUS LEVELS

Cervical
Thoracic
Lumbar
Sacral

<table>
<thead>
<tr>
<th>Neural Arch &amp; Its Process</th>
<th>Transverse Element</th>
<th>Costal Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrum</td>
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Image with diagrams showing the structure and elements of different vertebrae at various levels.
A TYPICAL VERTEBRA

Each vertebra has:
A BODY: anteriorly
A VERTEBRAL ARCH: posteriorly

Each arch has:
  2 pedicles, 2 laminae, a spinous process,
  a transverse process & a vertebral foramen

OSSIFICATION

Primary centres ( ) appear at 8-10 weeks intra-uterine. There
are 3:1 in the centrum & 1 in the base of each transverse
process. From the latter, ossification spreads to pedicle,
lamina, spinal process, body & facets

Secondary centres ( ) appear at puberty. 5: spinous process,
transverse processes, each annular epiphyseal rings

Fusion
Arches by 2 years
Arch/centrum by 7yrs
Secondary centres by 25yrs
AXIS - C2

Viewed from above

- Spinous process (thick, broad, bifid)
- Pedicle
- Greater occipital (C2 posterior ramus)
- Anterior ramus (C2)
- Lamina
- Inferior facet
- Foramen transversum
- Superior facet (large, flat)
- Apical ligament
- Alar ligaments

Lateral view

- Alar ligament
- Dens
- Groove for transverse ligament & bursa
- Anterior facet for arch of atlas
- Body
- Transverse process (posterior tubercle)
- Foramen transversum
- Inferior facet

Posterior view

- Dens (superiorly)
TYPICAL CERVICAL VERTEBRA

- C3-6
- Bifid spinous process
- Large triangular foramen
- Short wide pedicle
- Small body
- Foramen transversum
  Artery, vein, sympathetic from C6 to C1

- C6: Has carotid tubercle of Chassaignac (enlarged anterior tubercle over which passes the common carotid artery)

- C7: Vertebra prominens has vestigial anterior tubercle, long, non-bifid spinous process, small foramen transversum containing vein only (no artery). Note that C7 nerve is above C7 vertebra and C8 nerve is below it

**Viewed from above**

- Superior articular facet
- Posterior ramus
- Anterior ramus
- Costal element
- Foramen transversum
- Intertubercular (costotransverse) bar
- Posterior tubercles of transverse process
- Anterior tubercles of transverse process
- Neurocentral (uncovertebral) joint of Luschka (degenerative) on uncinate process

**Lateral view**

- Spinous process
- Inferior articular facet/process
- Posterior view
- Vertebral artery in foramen transversum
LUMBAR VERTEBRAE

TYPICAL VERTEBRA (L2)
- Superior facet
- Accessory
- Transverse process
- Short, thick pedicle
- Mamillary
- Processes

Viewed from above

Viewed from side

L5 viewed from above
- Wide, short pedicles
- Forward facing facets
- Thick short transverse process

Viewed from behind

Dorsal root between processes

Costal element (becomes a lumbar rib if not fused)
VERTEBRAL COLUMN - MOVEMENTS

CERVICAL
- Flexion
- Extension
- Lateral flexion

ATLANTO-OCCIPITAL
- Flexion/extension

ATLANTO-AXIAL
- Rotation only

THORACIC
- Rotation only

LUMBAR
- Flexion/extension
- Lateral flexion

SACRAL
- No movement

Movements at facet & intervertebral joints are individually small but accumulatively considerable.
VERTEBRAL COLUMN - JOINTS & LIGAMENTS

JOINTS

ARTICULAR FACET (zygapophyseal)
Plane, synovial, nerve supply by nerves above and below

NEUROCENTRAL (uncovertebral) JOINTS OF LUSCHKA
Cervical & T1 only, small on lateral side of body, between uncinate process and side of body. Probably degenerative

ATLANTO-OCCIPITAL
Synovial, weak anterior/posterior atlanto-occipital membrane.
Nodding movement

ATLANTO-AXIAL
Synovial, head pivoting. Ligaments are apical, alar, cruciform.
Posterior longitudinal ligament becomes membrana tectoria

LIGAMENTS

Interarticular
Between facet joints

Interspinous
Weak, fused with supraspinous

Supraspinous
White, strong, fibrous, into ligament nuchae above

Above becomes membrana tectoria (C2 to occiput)

Posterior longitudinal ligament. Attached firmly to disc, lightly to body for venous egress

Below finishes in sacral canal

2 other ligaments are: LIGAMENTUM FLAVUM between laminae like tiles on a roof - under surface of one above to outer surface of one below. Also INTERTRANSVERSE - between transverse processes - weak
ATLANTO-AXIAL & ATLANTO-OCCIPITAL JOINTS

Sagittal section of upper cervical spine

Anterior atlanto-occipital membrane
Anterior arch of atlas
Anterior longitudinal ligament
Apical ligament
Tectorial membrane
Superior band of cruciform
Transverse ligament of atlas
Inferior band of cruciform
Posterior longitudinal ligament
Dura

Alar ligaments
Capsule of atlanto-occipital joint
Foramen transversarium
Superior/inferior/transverse bands of cruciform ligament
Tectorial membrane (cut)

Looking into upper spinal canal from behind

Posterior atlanto-occipital membrane
Vertebral artery

C1
C2
Posterior view
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VERTEBRAL VENOUS PLEXUSES

**Anterior**
- External venous plexus. Anterior.
- Drain via vertebral bodies
- **VALVELESS**

**Posterior**
- External venous plexus. Posterior to ligamentum flavum
- **VALVELESS**

Drain into - veins:
- Cervical azygos
- Ascending lumbar lateral sacral

Internal vertebral veins. One set of anterior & two sets of posterior.
- Around dura & posterior longitudinal ligament. **VALVELESS**.
- Communicate above with occipital & basilar sinuses, segmentally receive veins from spinal cord & basivertebral veins

- Internal vertebral venous plexus
- Intervertebral veins which are valveless & connect with portal & systemic systems.
- Allow retrograde spread of cancer cells

Posterior, external vertebral venous plexus
- Lumbar vein & ascending lumbar vein
- Basivertebral veins
- Anterior, external vertebral venous plexus
SPINAL CORD - VEINS & SOME LIGAMENTS

**Basivertebral veins** emerge from foramina (●) in posterior vertebral bodies & drain into the **internal vertebral plexus** (anterior/posterior) which drains via the **intervertebral segmental veins** (with the nerve roots) into the **external vertebral plexuses** which, in turn connect above & below the diaphragm to the inferior & superior vena cavae via vertebral, azygos, lumbar & lateral sacral veins. These veins are **VALVELESS** and thus cancer cells from thyroid, breast, kidney & prostate can easily enter the bones.

The **posterior longitudinal ligament** attaches to discs only & not to the vertebral bodies so that there is free drainage of the basivertebral veins.

The dural sac finishes at S2 but the PIA MATER in the form of the filum terminale continues below S2 and attaches to the back of the coccyx.

The **DENTICULATE (dentate) ligament** is pia mater that connects the cord to the dura mater laterally between the exits sites for the nerves. It pierces the arachnoid mater. Note that the spinal roots of the accessory nerve (C1-5) emerge doral to the denticulate ligament, whereas the sensory roots emerge dorsal and the motor roots ventral to it.

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**SPINAL SUBARACHNOID SPACE**
- Volume 75ml
- Tapped during spinal puncture or anaesthetic below L2
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