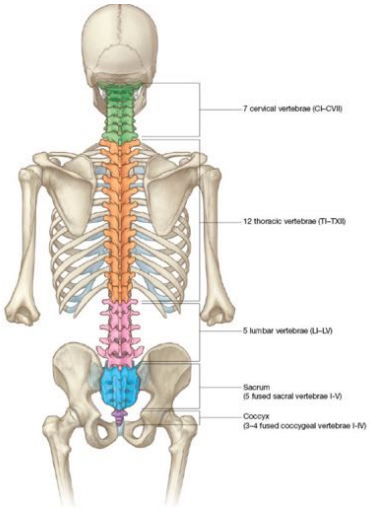
5.1: Vertebral column & back.

Overview.

- Bones
  - vertebral column.
  - typical vertebra.
  - vertebral canal.
  - spinal nerves.
- Joints
  - Intervertebral disc.
  - Zygapophyseal (facet) joint.
- Muscles
  - 2 compartments:
    - Extrinsic
    - Intrinsic
  - Lumbar fascia.
- Applied anatomy.

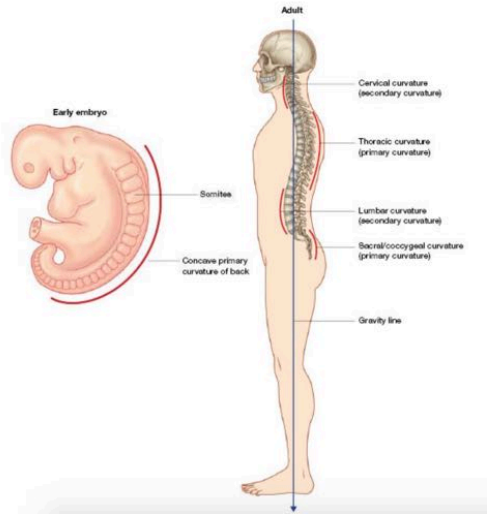
Bony framework of the vertebral column.

- The vertebral column is part of the axial skeleton and regionally distinct:
  - Cervical (7)
  - thoracic (12)
  - lumbar (5)
  - sacrum (5 - eventually fuse)
  - coccyx (2-4 fused - evolutionary remnant) vertebrae
    - coccygeal vertebrae vary between individuals.
- Each successive vertebra articulates to the previous one and form intervertebral joints (& discs).
- There are several foramina (opening) in the vertebral column such as:
  - the vertebral canal for the spinal cord.
  - the intervertebral foramen for the spinal nerves.
- Function:
  - It forms a central support for the central axis.
  - Movement.
    - Greater ROM (flexion extension etc.)
  - Protection of the nervous system.

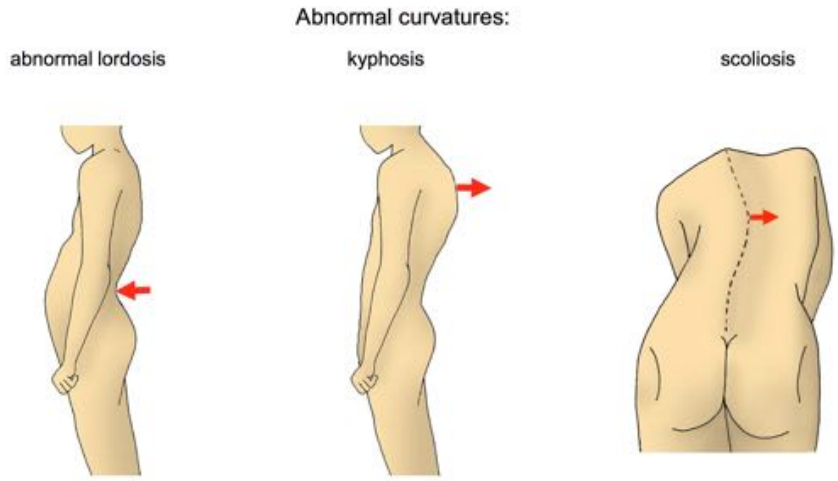


Structure of the vertebral column.

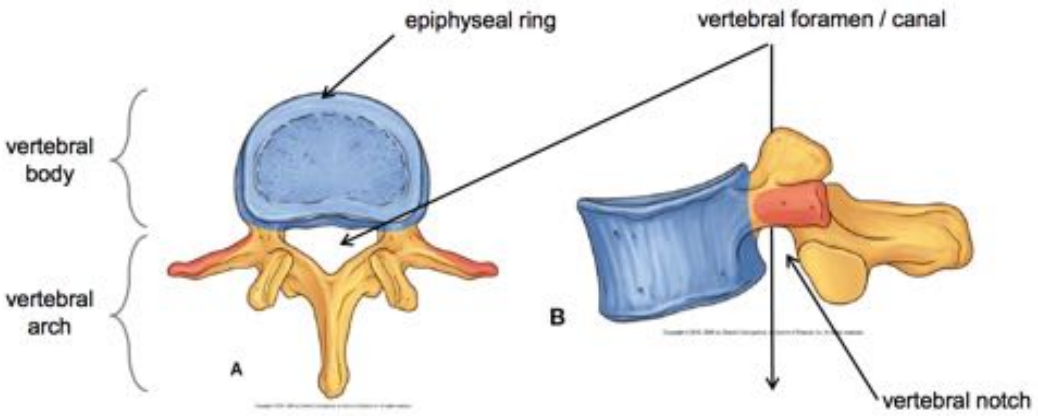
- Developmentally the vertebral column starts off as a single foetal/ primary C curve.
  - It is anteriorly concave.
- By about 3-4 months postnatally our muscles of the back grow and we develop secondary 'lordotic' curves in the cervical and lumbar regions.
  - Primary curve is retained in the thoracic and sacral region.
  - Secondary curve development is required for proper upright position.



- Abnormal curvature may occur which include
  - abnormal lordosis
    - usually an exaggerated lumbar curve
    - Obese man or pregnant women can develop this because the weight pulls the lumbar forward.
  - Kyphosis.
    - which gives a hunch back pose.
  - scoliosis
    - which involves curving of the vertebrae laterally.



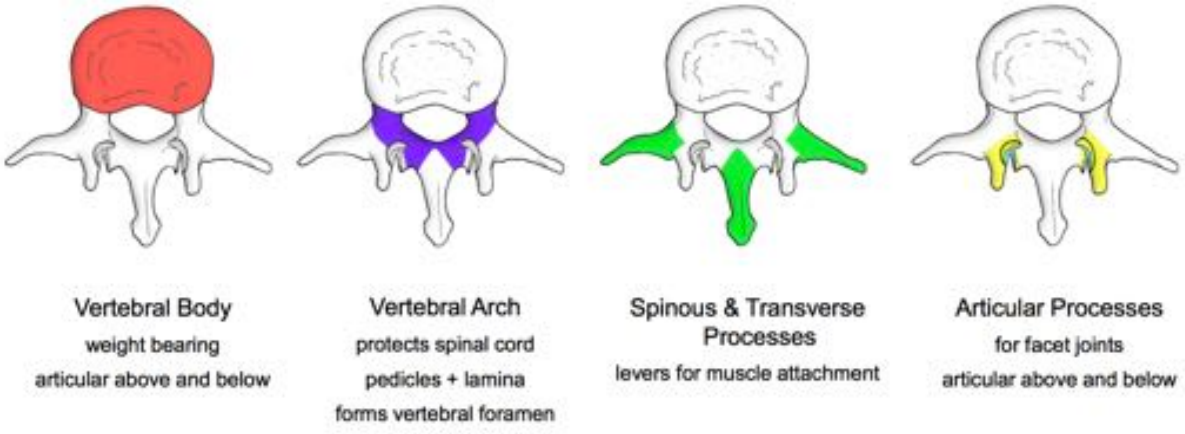
Structure of a typical lumbar vertebra.



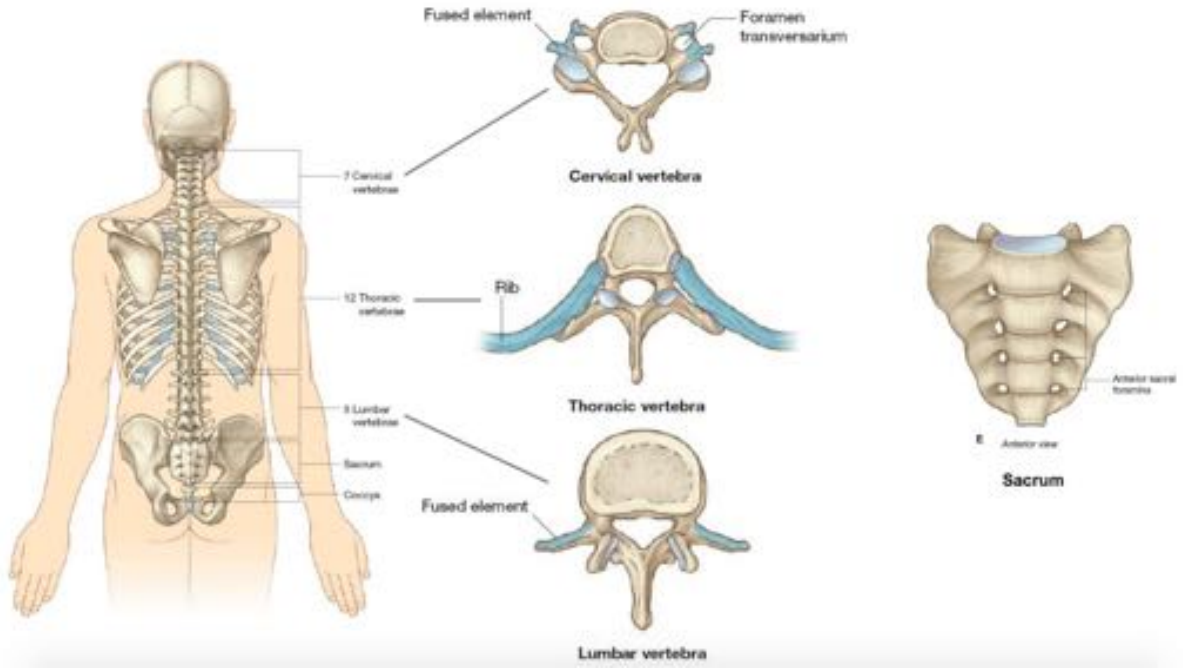
- Vertebrae are irregular bones consisting of a vertebral body and a vertebral arch.
  - In the body, the central region is rather roughened while the outer perimeter is rather smooth.
    - The smooth region is called the epiphyseal ring.
  - The arch is made up of the transverse, spinous, and articular processes.
- The middle opening is called a foramen.
  - Once we start stacking up these vertebra; the foramens then become a single canal which is where the spinal cord runs.
- The vertebral notch is the pit formed because the vertebral arch is not as large as the vertebral body.

- These parts have different roles:

Vertebral body	- weight bearing, they increase in size down the vertebral column as they need to support more weight.
Vertebral arch	- protects the spinal cord and forms the vertebral foramen with the pedicles and laminar. (collectively they form the internal portion of the arch) - The pedicle joins the vertebral body to the vertebral arch. - The laminar is part of the arch that forms the triangular top.
Spinous and Transverse processes	- levers for muscle attachment.
Articular processes	- for facet joints above and below, connecting to adjacent vertebrae.



- The vertebrae are regionally distinct.
    - They differ in size.
        - Cervical vertebrae are much smaller compared to the lumbar vertebrae.
            - This is because of the difference in weight beard.

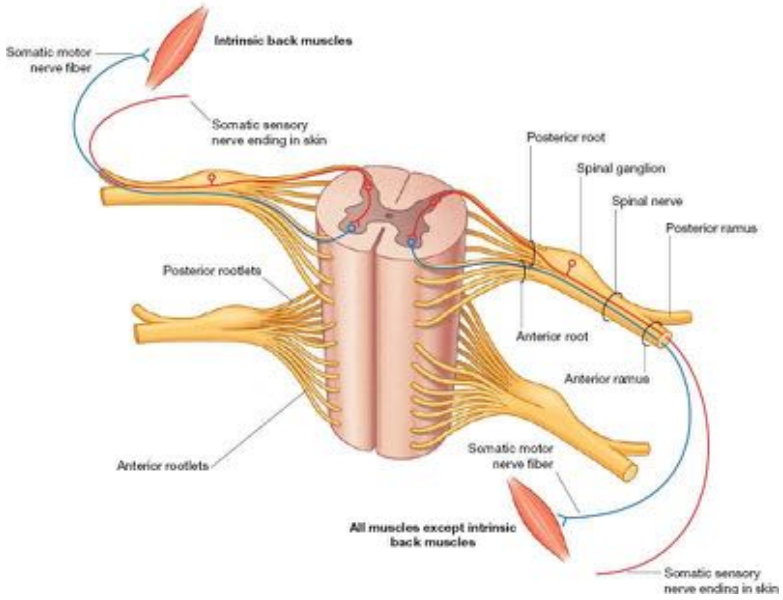


The vertebral canal and spinal cord.

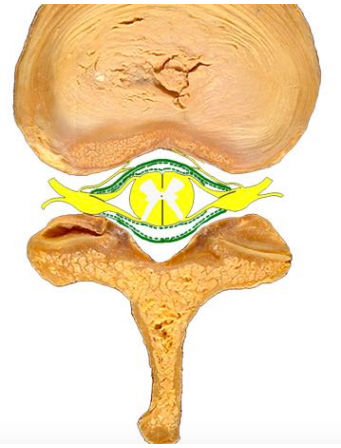
- The spinal cord does not pass entire length of vertebral column, terminates at L1/2.
  - However, the nerve roots do extend in a bundle called the cauda equina.
- The spinal cord has meninges just like the brain.
- The peripheral nerves coming from the spinal cord exit the vertebral column through the intervertebral foramen formed by the vertebral notches of adjacent vertebrae.

Spinal nerves.

- Spinal nerves emerge bilaterally from the spinal cord which consist of:
  - ventral (motor) roots; cell bodies in the spinal cord ventral horn.
  - dorsal (sensory) roots; cell bodies in the dorsal root ganglion.

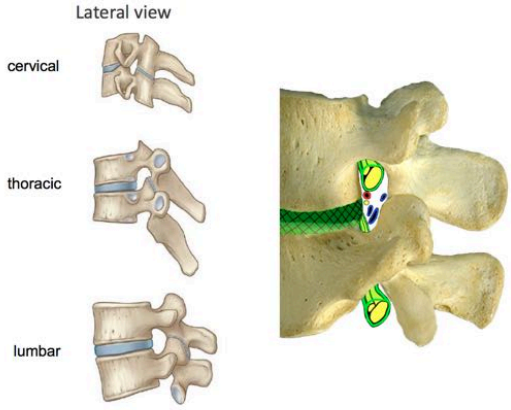


- As the mixed spinal nerves emerges from the intervertebral foramen, they divide into two major branches:
  - a posterior ramus, which only innervates:
    - intrinsic back muscles.
    - the associated facet joints.
    - the overlying skin on the back.
  - an anterior ramus, which innervates most other skeletal muscles and most remaining areas of the skin.



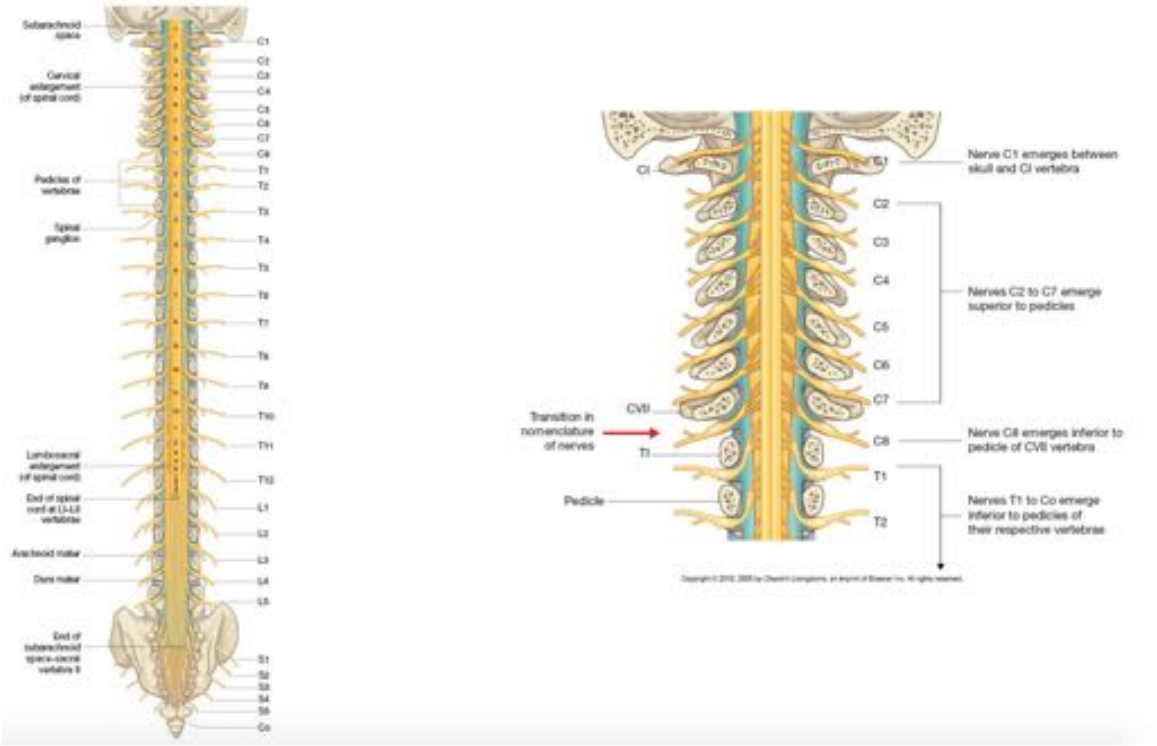
Intervertebral foramen.

- When the vertebrae articulate with each other, the notch turns into a foramen → intervertebral foramen.
- The mixed spinal nerve will then exit through here.



Nomenclature of the Spinal Nerves.

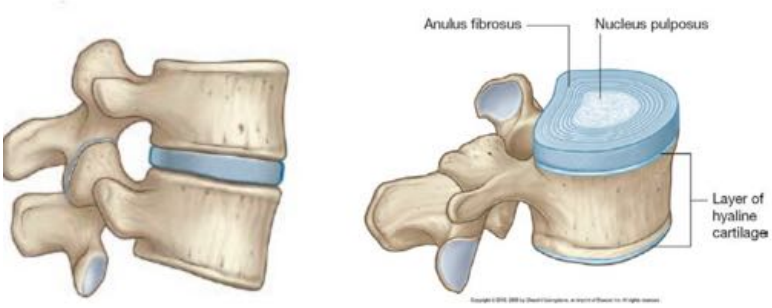
- Spinal nerves are given a name according to where they exit the spinal cord (although coccygeal vertebrae only give rise to one nerve).
    - The nerves are named by the vertebra that they exit superior to:
        - The nerve that exit above C1 is called C1 etc.
- (Exception is C8 nerve which is below C7 and above T1, this means there are 30 vertebrae and 31 nerves, 8 cervical nerves, only 7 cervical vertebrae).
    - From here there is a change in nomenclature of the nerve, they are named by the vertebra that they exit posteriorly to:
        - The nerve that exit below T1 is T1.



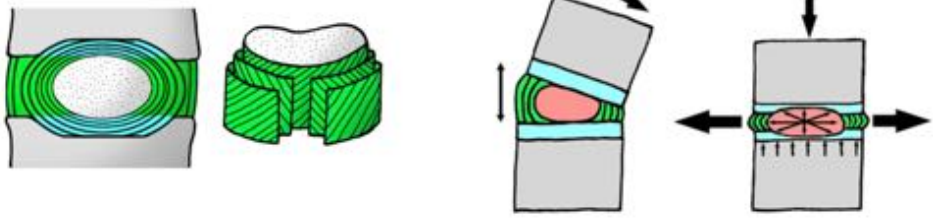
Joints of the vertebral bodies.

- There are two main types of joints in the spinal column:
    - Intervertebral joints are secondary cartilaginous joints in the vertebral bodies consisting of the nucleus pulposus in the middle surrounded by the annulus fibrosis (they look like the annual growth rings of a tree):

- The annulus fibrosis functions to keep the vertebrae together.
    - It attaches to the epiphyseal ring above and below.
    - consists of concentric lamellae (fibrous rings orientated obliquely at right angles) that enables movement in all directions without tearing.
    - It also serves to resist excessive movement.
- The nucleus pulposus functions to keep the vertebrae apart.
    - It is encapsulated within the anulus fibrosis.
    - They are gel like and consist almost entirely of water so you can't compress them only deform, they are shock absorbers



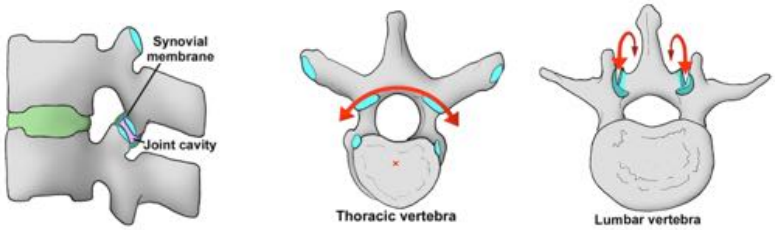
*we gradually lose water from the nucleus over day so they compress a little and we get a tiny bit shorter, we also lose weight from the discs as we age.



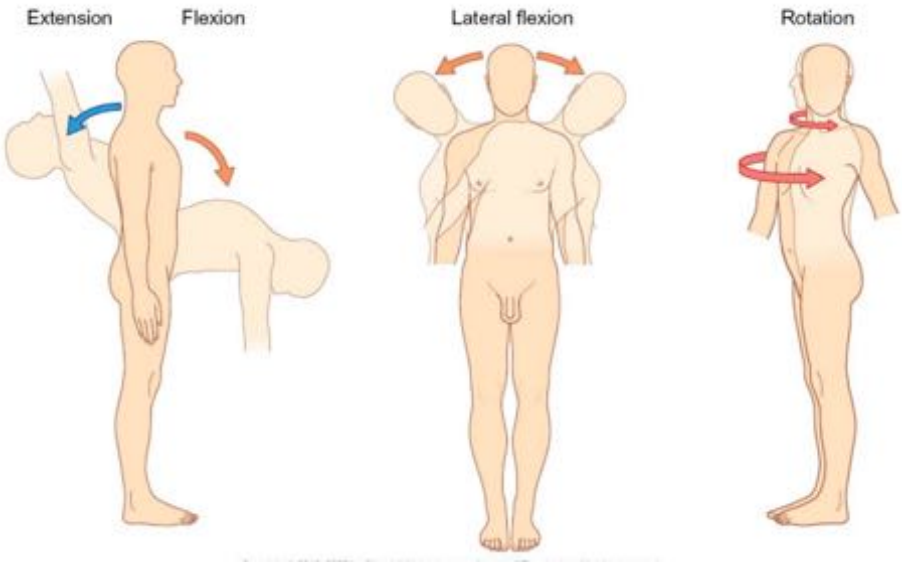
Anulus:	concentric fibrous rings orientated at right angles enables movement in all directions without tearing resists excessive movement	Nucleus:	deformable but not compressible 'shock absorber'

The 2nd type of joint:

- Zygapophyseal joints (facet joints)

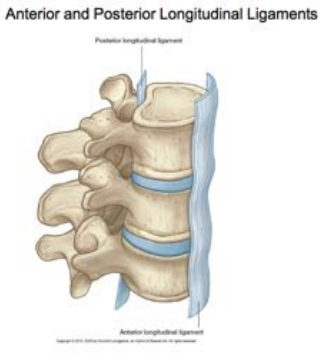


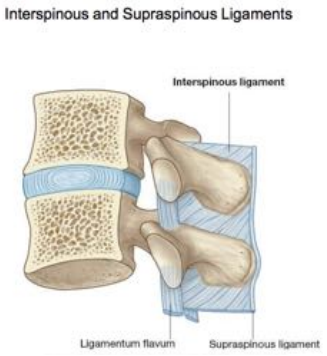
  - They are plane synovial joints which permit gliding along only one axis.
  - The movements available are determined by their shape and depth which varies depending on the regions of the spine. The orientation of them also differs regionally. E.g.
    - thoracic articular processes - orientated in the coronal plane and permit rotation
    - lumbar articular processes - orientated in the sagittal plane and permit flexion / extension

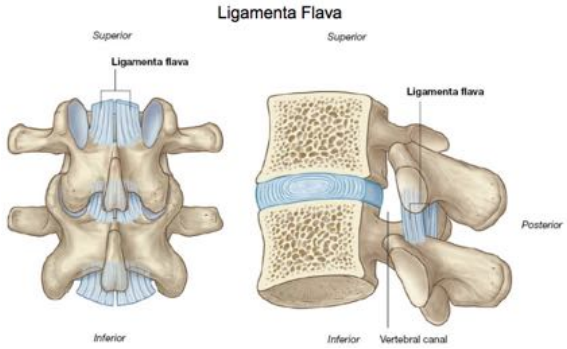


Ligaments of the vertebral column.
Joints are supported by ligaments and there are 5 important ligaments here that we need to know:

- Anterior and Posterior Longitudinal Ligaments
    - The posterior longitudinal ligament runs down the posterior side of the vertebral bodies and splays out to cover intervertebral discs when it reaches them. It reinforces the posterior aspect of the disc, and tends to cause disc bulges to move posterolaterally by stopping them from pushing out posteriorly. which compresses spinal nerves. Anterior longitudinal ligaments lie in front of the vertebral body, they are wider and much more simple.
- Interspinous and Supraspinous Ligaments
    - The interspinous ligament joins the spinous processes
- Ligamenta Flava
    - The ligamentum flavum runs between successive vertebral lamina, it's yellow because it contains a large amount of elastic fibres (unusual for a ligament). These elastic fibres allow the separation of lamina for flexion, although it still holds them together.

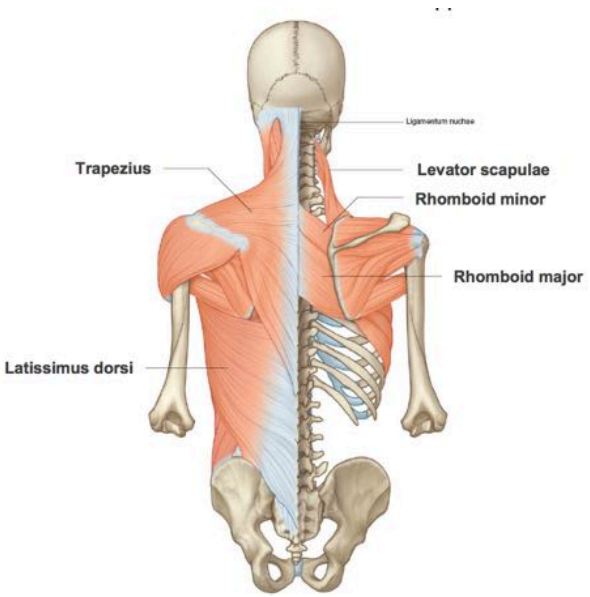




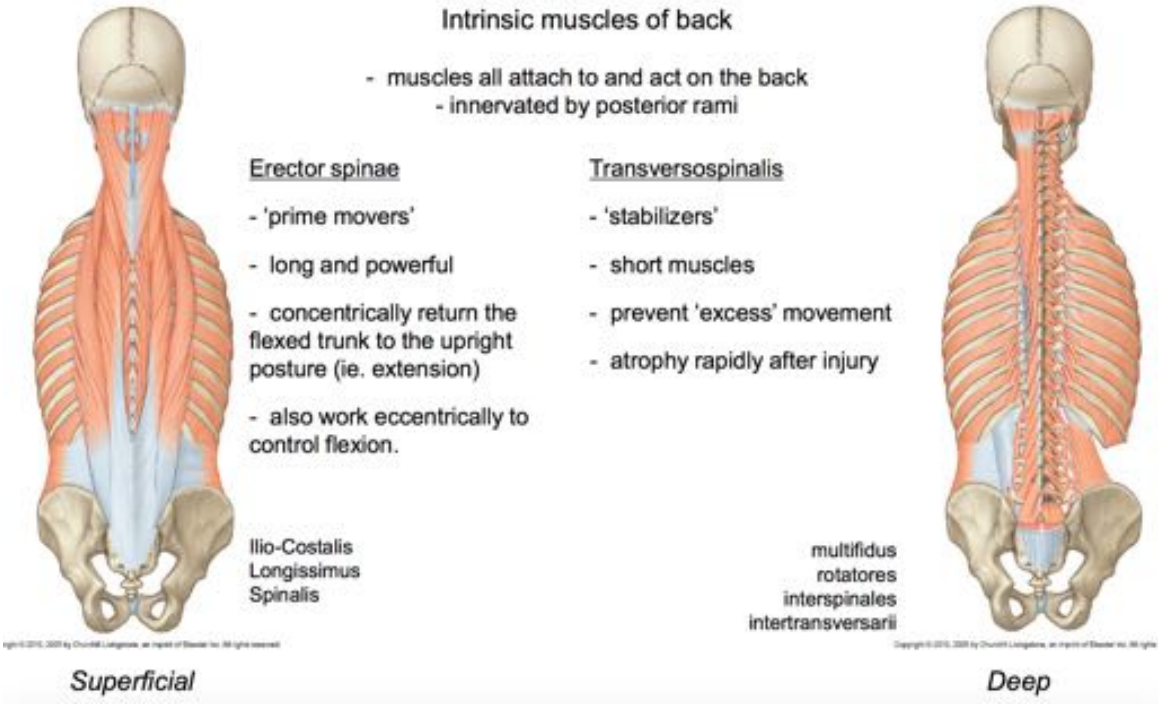


Muscles of the back.

- Extrinsic (superficial) muscles are those that only attach to the vertebrae at one point. They are not 'true' back muscles, the other attachment is to the upper limb.
    - Their primary function is on the upper limb.
    - They are innervated by Anterior Rami.
- We have four major extrinsic muscles in the back:
    - The trapezius attaches to the cervical and thoracic vertebrae, and the scapula.
        - Its main function is to stabilise and move the scapula.
    - The latissimus dorsi ("large muscle") attaches to the lumbar and sacral regions broadly, it comes up laterally and attaches to the humerus.
        - Responsible for movements such as pull-ups, row etc.
    - The rhomboid is divided into the major and minor, which both attach to the thoracic and cervical vertebrae.
        - Responsible for pulling scapulae medially etc.
    - The levator scapulae is a smaller muscle that elevates the scapula.
        - It attaches to the neck and scapulae.

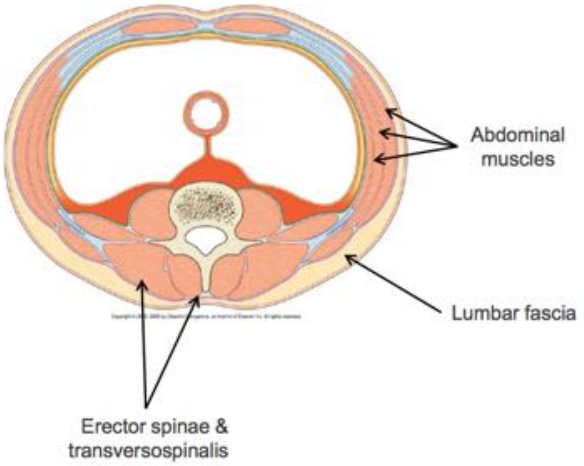


- Intrinsic (deep) muscles have both their origin and insertion in back structures.
    - Their primary function is to move the back.
    - They are innervated by Posterior Rami.
- We have two types:
    - The erector spinae which are prime movers responsible for maintaining upright posture (extension). They are long muscles that also work eccentrically to lower us down.
    - Transversospinalis muscles are shorter (passing only two vertebrae) and they are stabilisers that prevent excess movement. They atrophy rapidly after injury which causes longer lasting issues.



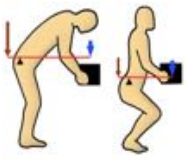
Lumbar fascia. (blue part in diagram above.)

- Fascia is everywhere in our bodies, it surrounds muscles, and groups of muscles doing similar actions allowing them to move together etc.
- Lumbar fascia:
    - Provides attachments for extrinsic/intrinsic muscles of the back
        - eg. trapezius, latissimus dorsi, erector spinae.
    - This forms a tight compartment for the intrinsic muscles (enhancing their actions).
- It is also continuous with the abdominal wall.
    - When lifting heavy, it is important to brace the abdominal muscle because this will trigger a reflex contraction of the back muscles which protects it from injury.



Applied anatomy of the back.

- Disc prolapse can occur if lifting heavy with improper form.
- Repetitive poor practices can force the nucleus back in a posterior direction which might impinge upon the nerves.
- The severity can vary:
    - Bulge = when the nucleus pushes into the annulus and creates a bulge slightly laterally in the vertebral canal.
    - Herniation = when the nucleus starts to leak out of the annulus and move into the vertebral canal.
    - Extrusion = when a small part of the nucleus separates and comes out into the vertebral canal.



Joint degeneration.

- Over time the nucleus dehydrates and the disc spaced is narrowed (less cushion).
    - This thinning of articular cartilage / narrowing of joint space forces the vertebra to come close.
- Irritation from bone to bone contact can cause formation of bony outgrowths called osteophytes.
    - Osteophytes may encroach and impinge on adjacent structures.
        - E.g. spinal canal, intervertebral foramen.
    - This causes severe pain especially with movement or weight bearing in the direction of osteophyte as in comes in contact with other bones.