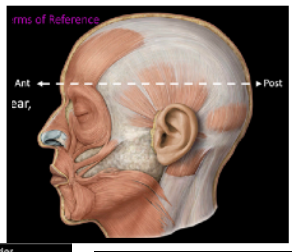
Introduction and Body Segmented Plan (W1)

Introduction to Anatomy (L1)

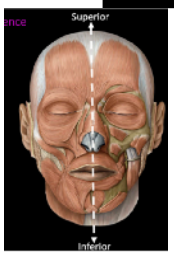
Anatomy is
- The study of the human form
- Describes structures and the relationship between them
  - Static position to base these references on

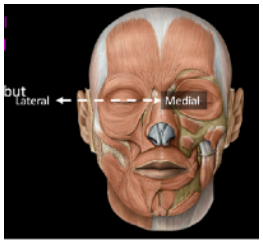
Anatomical Position
- Palms forward
- Face forward
- Terms that describe structures and their relationships



Anatomical Terms of Reference
- In front = **Anterior**
- Behind = **Posterior**
- The eye is anterior to the ear, but posterior to the nose

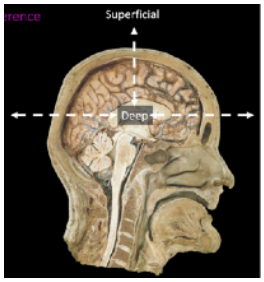
Anatomical Terms of Reference
- Above = **Superior**
- Below = **Inferior**
- The mouth is superior to the chin, but inferior to the eyes

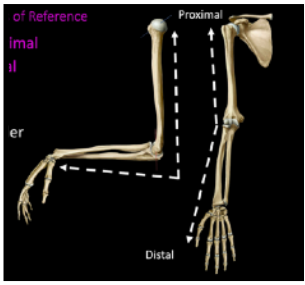




Anatomical Terms of Reference
- Closer to the mid-line = **Medial**
- Towards the side = **Lateral**
- The eye is medial to the ear, but lateral to the nose

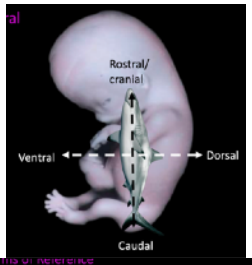
Anatomical Terms of Reference
- Close to the surface = **Superficial**
- Close to the core = **Deep**
- The skull is superficial to the brain, but deep to the skin

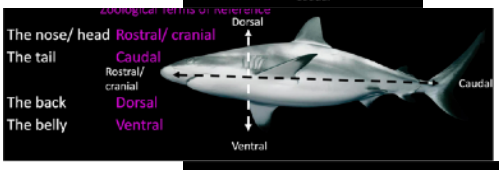




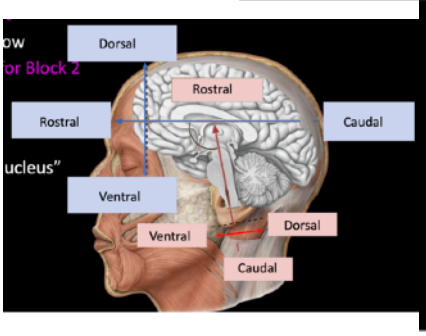
Anatomical Terms of Reference
- Close to the origin = **Proximal**
- Further from the origin = **Distal**
- The elbow is proximal to the hand, but distal to the shoulder

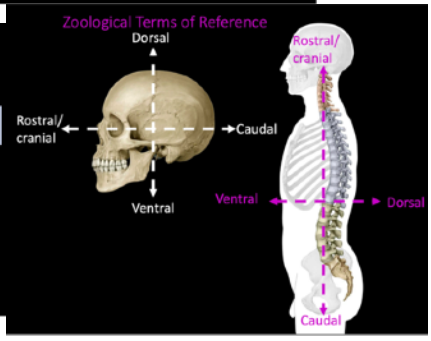
Embryological Terms of Reference
- Towards the head/nose (top) = **Rostral/cranial**
- Towards the tail (bottom) = **Caudal**
- Towards the back (back) = **Dorsal**
- Towards the belly (front) = **Ventral**



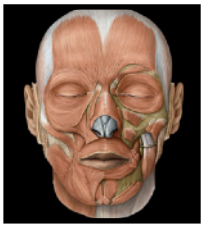


Zoological Terms of Reference
- The nose/head = **Rostral/Cranial**
- The tail = **Caudal**
- The back = **Dorsal**
- The belly = **Ventral**



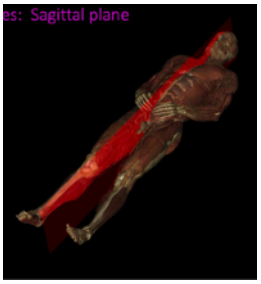


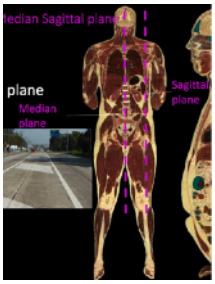
Zoological Terms of Reference
EXCEPTION (humans)



Compound Terms
- Terms can be joined to form compound terms
- Mouth is inferomedial to the eyes

Anatomical Planes
- Body can be cut in various ways
  - 3 orthogonal planes
  - Some variations

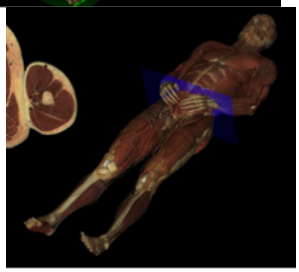




Sagittal Plane
- Seperate left form right
- Infinite sagittal planes
- Bow an arrow cuts down the line

Median Sagittal Plane
- Only one occurs in the mid-line of the body
  - Known as the median sagittal plane
  - AKA median plane/ mid-sagittal plane
- Cut from nose to back of head

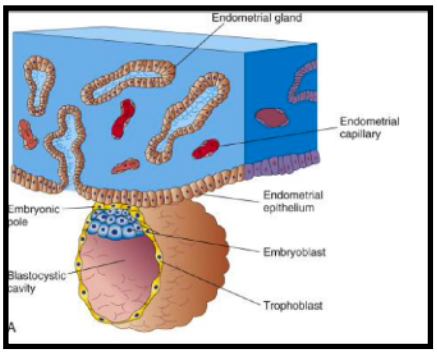
Coronal planes
- Separate anterior from posterior
- Coronal/frontal planes
- Separate front and back



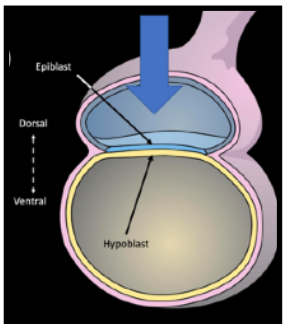
Transverse plane
- Transverse
- Horizontal
- Axial (imaging)
- Horizontal layers of body

Segmented Body Plan and General Organisation of the Spinal Cord (L2)

Some starting words
- A recurring doublet
- Epi-
  - '**upon**'
  - **Epi**dermis
- Hypo-
  - '**below**'
  - **Hypo**dermis
- -blast
  - 'Germ or bud' - sense of '**build**' or 'form'
  - Osteoblasts - cells that build bone
- -clast
  - '**Broken** [in pieces]'
  - Osteoclast - cells that degrade bone

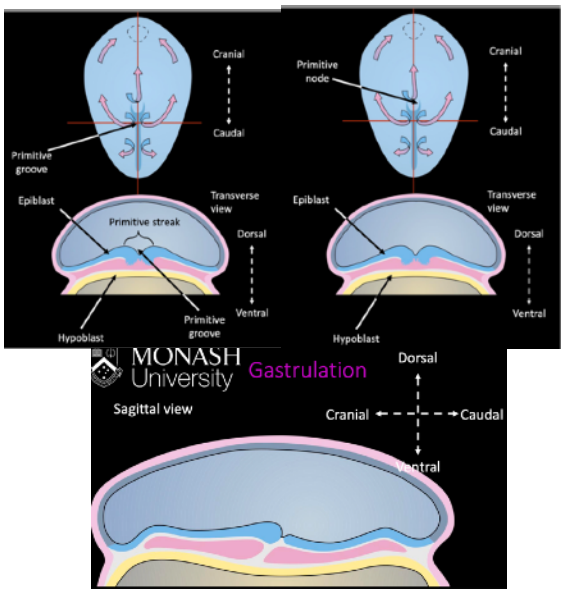


The story so far
- Fertilised egg starts dividing as it migrates into the uterus
- Becomes polarised as cells collect on one side and a cavity on the other
- Here referred to as blastocyst
- Blastocyst has a shell of supportive cells - trophoblast
- Within which is the embryo blast at the embryonic pole, and a blastocystic cavity
- -cyst = 'bladder/pouch'



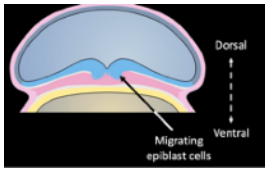
The story so far
- Blastocyst implants itself in the uterine wall
- Cavity created within cells at embryonic pole
- Embryoblast differentiates into two distinct cell populations

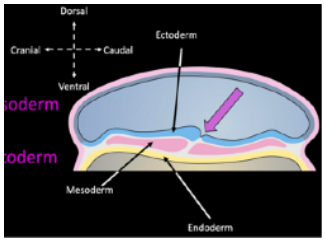
Bilaminar Embryonic Disc
- Disc of two (bi-) flat sheets (laminae)
- **Epiblast**
  - Epi - Greek: ‘upon’, -blast: ‘build”
- **Hypoblast**
  - Hypo - Greek: ‘below’, -blast: “build”
- Two layers to three



Gastrulation
- **Primitive streak**
  - Thickened band of epiblast
  - Progresses from **caudal** (bottom) to **cranial** (top)
  - Indented by **primitive groove**
- **Primitive node**
  - Cranial front of primitive streak
  - Indented by **primitive pit**

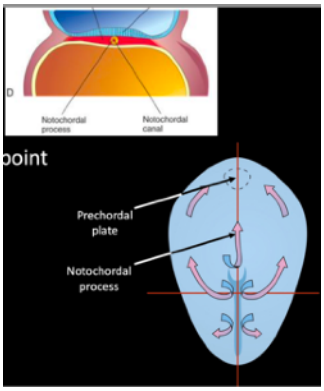
Gastrulation
- **Epiblast** cells migrate into **primitive pit and groove**
  - **Ingression**
- After gastrulation:
  - Epiblast and hypoblast change terms
- Hypoblast becomes **endoderm**
  - Endo- Greek: ‘within’
- Migrating epiblast becomes **mesoderm**
  - Meso- ‘middle’
- Remaining epiblast becomes **ectoderm**

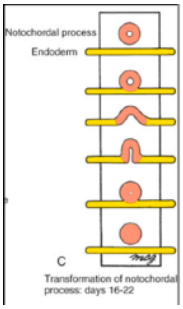




Germ Layer Derivatives
- Ectoderm
  - Brain and spinal cord
  - Nerves
  - Skin, nails and hair
- Mesoderm
  - Heart and kidneys
  - Bones, cartilage and muscles
  - Blood cells and vessels
- Endoderm
  - Lining of the respiratory and gastrointestinal systems
  - Liver, pancreas and bladder

Back to gastrulation
- Primitive streak extends cranially (upwards)
- Epiblast cells migrate into the primitive groove
  - Most have a lateral or cranio-lateral path
  - Some newly mesodermal cells extend cranially along the **midline**

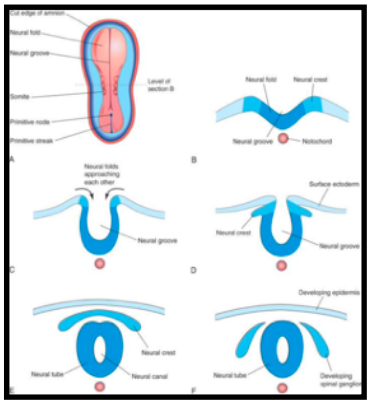




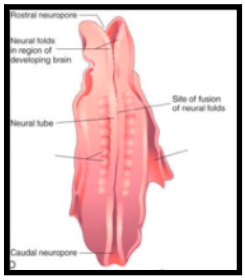
Notochordal Process
- Midline longitudinal tube
  - Thick walls
  - Cavity (**notochordal canal**)
- Extends cranially until it reaches a point
  - **Prechordal plate**

Steps to the Notochord
- Notochordal process (hollow tube)
- Notochordal plate (flattened)
- Notochord (solid cylinder, no lumen)

Notochord
- 590 million years ago
- Chordate creatures
- Stiff cartilaginous rod
  - Stability and flexibility
- **Humans**
  - **Fibrocartilagenous intervertebral discs**



Neurulation
- Development of central nervous system (CNS)
  - Brain and spinal cord
- As notochord develops
  - Overlying ectoderm differentiates (top right corner, B)
  - **Neuroectoderm**
- Neural plate
  - Thick (dorsoventrally)
  - Expanded cranially (brain)
- Neural plate folds dorsally (middle left, C)
  - **Neural folds**
  - **Neural crest** at free margin
  - **Neural base** at base
- As neural folds approach each other, neural crest separates (middle right, D)
- Folds completely to form **neural tube** (bottom left, E)
- Neural rest splits in two
  - Dorsolateral to neural tube



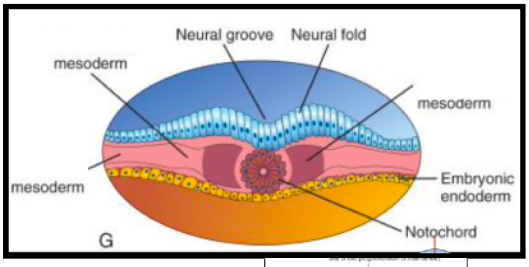
Neuropores
- Neural folds fuse in future thoracic region first
  - Zips up rostrally (upwards) and caudally (downwards)
- Unfused portions are neuropores
  - Rostral neuropore
  - Caudal neuropore

Neural Tube Defects
- Failure of neural tube to fully close
- **Neuropores remain open**
  - Caudal neuropore: spina bifida
    - Herniation of meninges with or without spiral cord
  - Rostral neuropore: encephalocele
    - Herniation of brain and cerebral ventricles

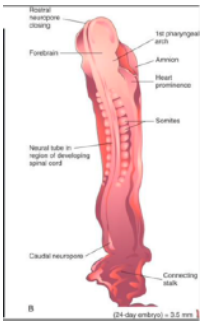
Neural Tube
- Brain and spinal cord (**CNS**)

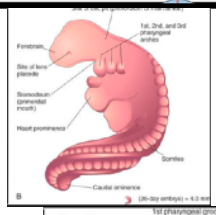
Neural crest cells
- **Ganglia** (cell bodies outside CNS)
  - Spinal nerves
  - Most cranial nerves
  - Autonomic nerves

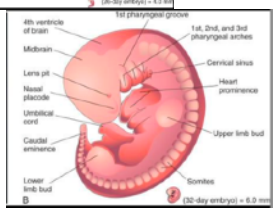
Neural Crest Cells
- Migrate extensively



Mesoderm
- Mesoderm either side of notochord
  - **Paraxial mesoderm**
- Mesoderm in between
  - **Intermediate mesoderm**
- Mesoderm off to the sides
  - Lateral plate mesoderm



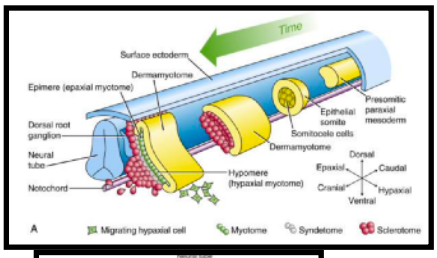




Paraxial Mesoderm
- Initially arranged into continuous longitudinal bands
- Quickly segment into **somites**
  - Soma, Greek: 'body'
  - Progressive formation form cranial (top) to caudal (bottom)
- First pair at day 20, complete day 30
- **42** to **44 pairs**

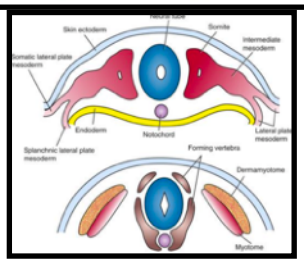
Somites
- Eventually form:
  - Muscular and skeletal tissues of trunk and limbs
  - Skin of the back (dermis)
- Prior to this the somites must differentiate

Somite differentiation
- Somite differentiates into
  - Schlerotome
  - Dermomyotome

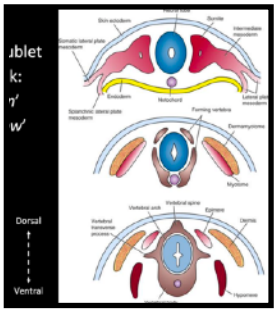


Schlerotome
- **Sclero**-, Greek: 'hard, harsh'
  - Hardening of arteries "atherosclerosis"
  - Forms **vertebrae** and other **skeletal tissues** that are 'hard'

Dermomyotome
- Further differentiates:
  - **Dermis**
    - Derma/demo-, Greek: 'skin, hide, leather'
    - Goes on to form **deep layers of skin**
  - **Myotome**
    - Myo-, Greek: 'muscle'
    - Forms most **skeletal musculature**



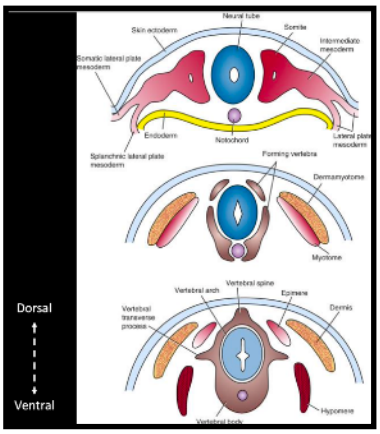
Myotome
- Further divides:
  - **Epimere**
    - Dorsal segment
  - **Hypomere**
    - Ventral segment
- A recurring doublet



- Epi- ‘upon’ and Hypo- ‘below

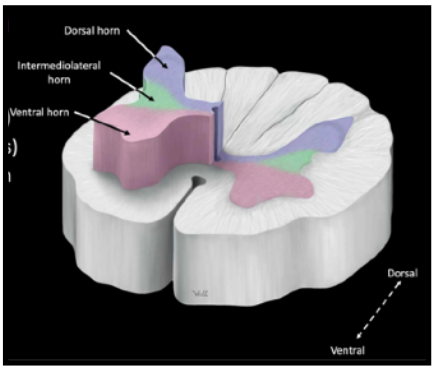
Summary
- Somite
  - **Sclerotome**
    - Skeletal tissues
  - **Dermomyotome**
    - Dermis of back (deep layer of skin)
    - **Myotome** (skeletal muscle)
      - **Epimere** (dorsal segment)
      - **Hypomere** (ventral segment)

Epimere/Hypomere
- Epimere
  - Forms muscles upon the axis (i.e. **dorsal**)
  - **Epaxial** muscles
- Hypomere
  - Forms muscles below the axis (i.e. **ventral**)
  - Hypaxial muscles



Epaxial/Hypaxial
- **Epaxial**
  - Dorsal to vertebral column (enclose spine)
    - Except extrinsic back muscles
- **Hypaxial**
  - Ventral to vertebral column
    - Excludes muscles of head and neck

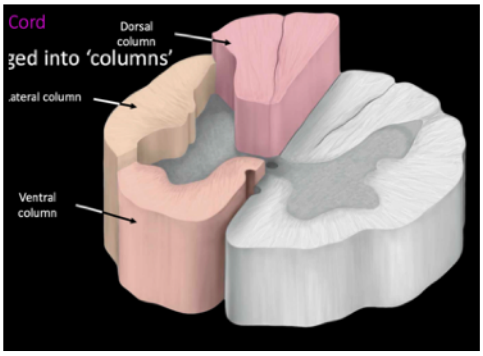
Central Nervous System: General
- **Grey matter**
  - Cell bodies
  - Local processing
- **White matter**
  - Axons
  - Highway
- Sensory
  - **Afferent** (arriving to cell) (CNS to PNS)
- Motor
  - **Efferent** (exiting cell) (PNS to CNS)



Spinal cord
- **Grey matter** is deep
- Arranged into ‘horns’
  - **Dorsal horn** (afferents) (blue)
  - **Ventral horn** (efferents) (pink)
  - **Intermediolateral horn** (autonomic) (green)

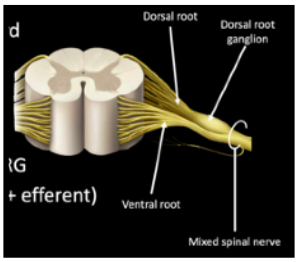
Mnemonic: SAME DAVE
- **S**ensory
- **A**fferent
- **M**otor
- **E**fferent

- **D**orsal
- **A**fferent
- **V**entral
- **E**fferent

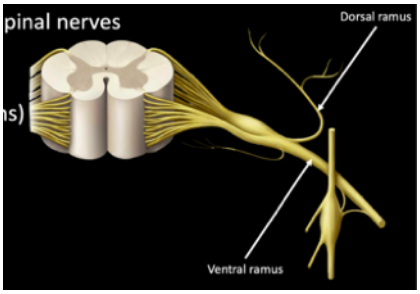


Spinal Cord
- White matter arranged into 'columns'
  - Dorsal column
  - Lateral column
  - Ventral column

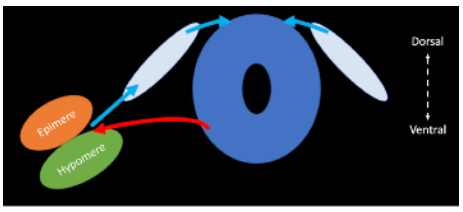
Spinal Cord/Spinal Nerve Segment
- **Roots** - enter or exit spinal cord
  - **Dorsal root** (afferent)
    - Dorsal root ganglion (DRG) - cell bodies of sensory nerves are located
      - Neural crest cells (the ones that didn't migrate during neuralation)
  - **Ventral root** (efferent)
- Union of the roots after the DRG
  - Mixed spinal nerve (afferent + efferent)
  - Distal to mixed spinal nerve

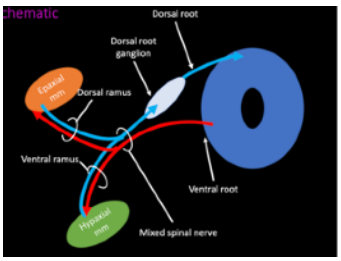


Spinal Cord/Spinal Nerve Segment
- Ramus/rami — branches of spinal nerves
  - Afferent + efferent
  - Latin: '**branch**'; branching consequences (ramifications
- **Dorsal ramus (epaxial musculature)**
  - Innervates epaxial musculature
  - Aswell as skin that is derived dermis part of Dermomyotome
- **Ventral ramus** (**hypaxial**)
  - Innervates hypaxial musculature
  - Aswell as sensory innervation from the skin of lateral and ventral



Schematic





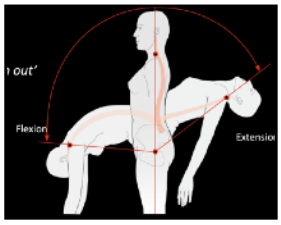
Segmentation
- **Dermatome**
  - Segment of **skin** innervated by a spinal segment
- **Myotome**
  - Segment of **muscle** innervated by a spinal segment

Body Walls and Compartments (W2)

Skeletal Framework of the Trunk (L1)

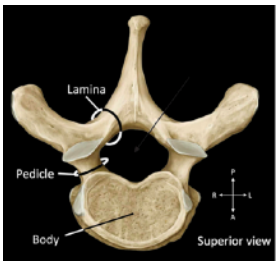
Some starting words

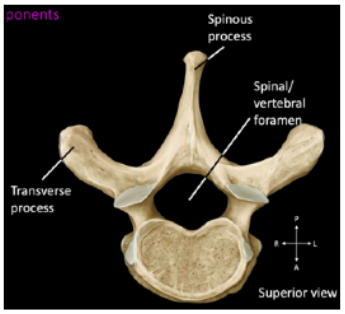
- **Foramen**: Latin 'hole'
  - Formina plural
- **Inter**-: Latin 'between'
- **Intra**- Latin 'within'
- **Articulation**: Latin 'joint'
  - From the Greek stem arthro-
  - Arthritis: Inflammation of the joint
  - Articular surface: joint surface
  - Someone who joins many words together is articulate
  - Different ideas are tied together in an article
- **Vertebrae**: Latin 'turning'



Movements of Vertebral Column

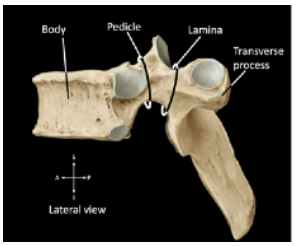
- Bending forwards: **Flexion**
  - Flexion: Latin 'bending'
- Leaning backwards: **Extension**
  - Extension: Latin: 'straighten/stretch out'
- Lateral flexion

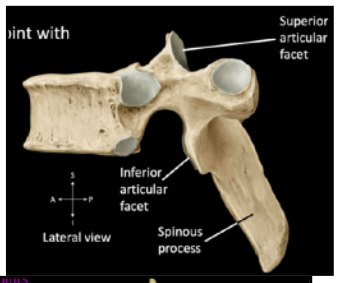


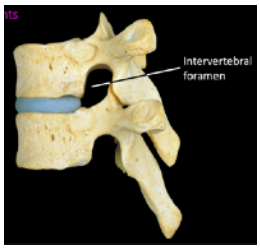


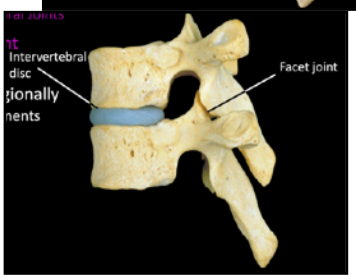
Vertebrae - components

- Superior view
- **Body**
  - Supports load
- **Pedicle** (Latin: 'little foot')
  - Posterior projection
- **Lamina**
  - Flat sheet
- **Spinal/vertebral foramen**
  - Encloses spinal cord
- **Spinous process**
  - Posterior projection
- **Transverse process**
  - Lateral projection
- **Superior articular facets**
  - Forms synovial (fluid-filled) joint with vertebra above
- **Inferior articular facets**
  - Forms synovial joint with vertebra below
- **Intervertebral foramen**
  - Conveys spinal nerves
- **Facet/zygapophyseal joint**
  - Synovial (fluid filled)
  - Orientation changes regionally
    - Impacts regional movements
- **Intervertebral disc**



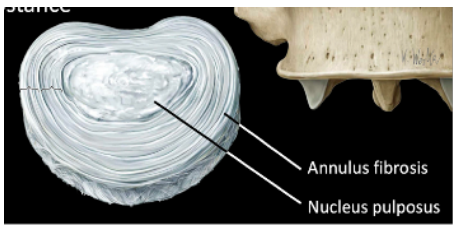




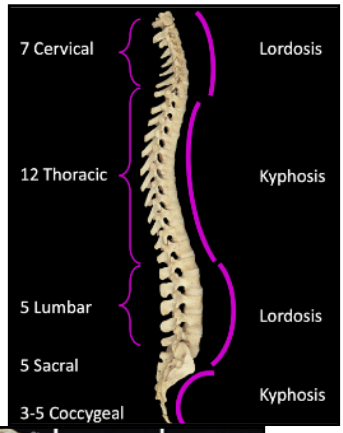


Intervertebral Discs

- Fibrocartilage between adjacent vertebrae
  - Notochord
- Example of symphysis
  - Type of cartilaginous joint
    - Rather than bone and bone, it is bone and cartilage
- **Annulus fibrosis**
  - Ring of fibrous tissue



- Latin: ‘little ring’; anus [ring], -ulus/ulum
- **Nucleus pulposus**
  - Core of gel-like substance



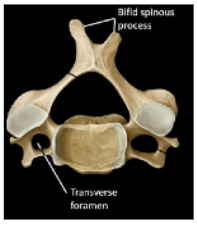
Vertebral Column
- 33 vertebrae, responding to those somites we saw last week, derived from sclerotome
- Regions
  - **Cervical** (7 cervical vertebrae)
  - **Thoracic** (12 thoracic vertebrae)
  - **Lumbar** (5 lumbar vertebrae)
  - **Sacral** (fused) (5 sacral vertebrae)
  - **Coccygeal** (fused) (3-5 coccygeal)
- Naturally curved
  - **Lordosis**
    - Convex anteriorly (post-natal development)
  - **Kyphosis**
    - Concave anteriorly

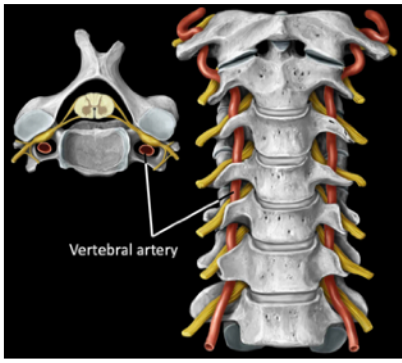
Vertebral column
- Vertebral bodies increase in size from cervical (top) to lumbar (middle/ bottom)
  - Supporting more mass

Scoliosis
- Lateral curvature of the vertebral column

Cervical Vertebrae (7)
- **Cervix**: Latin ‘neck’
- **Obliquely transverse** (anteroposterior) **facet joints**
  - Flexion/extension
  - Lateral flexion
  - Rotation

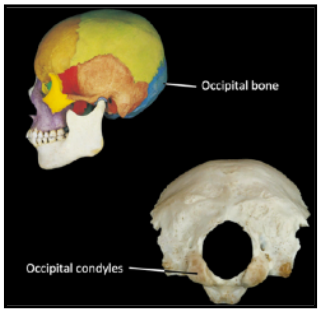
Cervical Vertebrae — Typical Features
- Small, oval-shaped bodies
- Large triangular vertebral foramen
- **Bifid spinous process**
- Transverse foramen





Transverse foramen
- Conveys **vertebral artery**
- Supplies blood to the brain stem
- Doesn’t course through transverse foramen of C7

Vertebral Artery Dissection
- Damage to vertebral artery can be **fatal**
- Can result in locked-in syndrome
  - Brianstem stroke
  - Loss of all motor control except eye movement



Occipital Bone
- Articulates with C1 via **occipital condyles**
  - Condyle: Greek ‘knuckle’