

Introduction and Body Segmented Plan (W1)

Introduction to Anatomy

Anterior: In front **Posterior:** Behind
Superior: Above **Inferior:** Below
Medial: Closer to midline. **Lateral:** Towards the side
Superficial: Close to surface **Deep:** Close to core
Proximal: Close to origin **Distal:** Further from origin
Rostral/Cranial: Towards head **Caudal:** Towards tail
Dorsal: Towards back **Ventral:** Towards belly

Sagittal Plane

- Separate left from right (infinite sagittal planes)
- Median Sagittal Plane: mid-line of body (only one)
- Between the eyes

Coronal Plane

- Separate anterior and posterior
- Like crown

Transverse Plane

- Horizontal cut, separate superior and inferior part of body
- Axial (in imaging context)

Segmented Body Plan and Spinal Cord

Epi-: Upon **Hypo-:** Below
-blast: Build **-clast:** Broken **-cyst:** 'pouch'

Bilaminar Embryonic Disc - 2 flat sheets

- **Epiblast:** 'upon build'
- **Hypoblast:** 'below build'
- Two layers form three later in gastrulation

Gastrulation

Primitive streak: thickened band of epiblast, progresses from caudal to cranial. Primitive groove within primitive streak, small groove

Primitive node: cranial front of primitive streak. Primitive pit

- Epiblast cells migrate into primitive pit and groove
- Hypoblast becomes **endoderm**. Migrating epiblast becomes **mesoderm**. Remaining epiblast becomes **ectoderm**

Neurulation - development of brain and spinal cord from notochord

- Neuroectoderm.
- Neural plate: Neural fold (spinal canal and brain), neural crest (developing PNS)
- Neural folds fuse in thoracic region, unfused at rostral and caudal

Paraxial Mesoderm (mesoderm either side of notochord)

- Somites (42-44 pairs) eventually form muscular and skeletal tissues of trunk and limbs. Skin of back
- **Schlerotome** (differentiation of somite)
 - Vertebrae, skeletal tissues (ribs, part of skull) (hard)
- **Dermomyotome** (differentiation of somite)
 - **Dermis:** deep layers of skin
 - **Myotome:** Skeletal musculature
 - **Epimere:** Dorsal segment
 - **Hypomere:** Ventral segment
- **Epimere:** forms **epaxial** muscles (dorsal to vertebral column)
- **Hypomere:** forms **hypaxial** muscles (ventral to vertebral column)

Spinal Cord

- Grey matter (cell bodies) is deep. Arranged into **3** horns
- **Dorsal** horn (afferent). **Ventral** horn (efferent). **Intermediolateral** horn (autonomic)
- Afferent (sensory). Efferent (motor)
- White matter (axons)
- Dorsal, lateral, ventral column
- **Roots** - enter/exit spinal cord
 - **Dorsal** root (afferent, sensory). Form **DRG** - cell bodies of sensory.
 - **Ventral** root (efferent, motor). Meet dorsal root -> **mixed spinal nerve** (afferent + efferent)
 - **Ramus/rami:** branch of mixed spinal nerve
 - **Dorsal ramus:** epaxial. **Ventral ramus:** hypaxial
- **Dermatome:** innervated skin. **Myotome:** innervated muscle

Body Walls and Compartments (W2)

Vertebrae - components (33 vertebrae overall)

- **Body** (supports load), **pedicle**, **lamina** (flat), **vertebral foramen**, **spinous process**, **transverse process**, **superior articular facets**, **inferior articular facets**, **intervertebral foramen** (conveys spinal nerves), **facet** (forms synovial joint), **intervertebral disc**

Intervertebral Disc - fibrocartilage between adjacent vertebrae

- **Annulus fibrosis:** outside fibrous tissue ring.
- **Nucleus pulposus:** core of gel-like substance

Cervical Vertebrae (7) - lordosis (inward projection)

- **Obliquely transverse facet** joints (anteroposterior)
- Small, oval shaped bodies. Bifid spinous process
- **Transverse foramen**, conveys **vertebral artery (brain stem)**
 - Doesn't course through C7
- **Occipital condyles** of occipital bone articulates with **C1**
- **C1 Atlas:** no vertebral body, no spinous process (posterior and anterior tubercle), large lateral mass that supports head, posterior and anterior arch. Atlanto-Occipital Joint
- **C2 Axis:** Dens/odontoid process, contains body of C1. Antanto-axial joint allows pivoting of head around Dens.
- **C7 Vertebra Prominens:** Elongated, palpable

Thoracic Vertebrae (12) - kyphosis (outward projection)

- **Coronal plane** facet joints - facilitate rotation, restricts flex/ext
- **Heart-shaped vertebral bodies**, small oval-shaped **vertebral foramen**, long, inferiorly projecting **spinous process**, articulate with ribs (**demifacets** on vertebral body + **transverse facet**)
- T1, T10-12 has **full facet** (not demifacet)

Lumbar Vertebrae (5) - lordosis (inward projection)

- **Sagittal plane** facet joints - facilitate flexion/extension, restricts rot.
- L5 is atypical - articulates with sacrum
- **Large**, cylindrical **vertebral body**, **triangular vertebral foramen**, **short transverse process**, **mamillary processes**, thick **short spinous process**

Sacrum (5 fused segments) - kyphosis (outward projection)

- **Auricular surface:** articulates with pelvis, large facet
- Ala: superior portion - '**sacral ala**'.
- 'Lateral part' is inferior to 'sacral ala'
- **Promontory:** flattened superior portion. Supports L5 body
- **Anterior sacral foramina** (4): course of ventral rami
- **Posterior sacral foramina** (4): course of dorsal rami
- **Median sacral crest:** instead of spinous processes

Coccyx (3-5 fused segments) - vestigial tail - kyphosis (outward proj.)

Sternum - manubrium, body, xiphoid process

- **Manubrium** (superior), **body**, **xiphoid process** (inferior)
- Manubrium: clavicular notches (sternoclavicular joint) - superolateral
- Jugular notch: palpable depression, superomedial
- 7 costal facets on body, articular with ribs (Rib 1 with manubrium, Rib 2 with manubrium and body, Rib 3-7 with body)

Ribs - typically 12: 1-7 true, 8-10 false, 11-12 floating

- Articulate with **thoracic vertebrae posteriorly**, terminate anteriorly as **costal cartilage**
- Ribs, **costochondral joint**, costal cartilage, **sternochondral joint**, sternum
- **True ribs** (1-7): costal cartilage directly attaches to sternum
- **False ribs** (8-10): indirectly attaches via cartilage of 7th rib
- **Floating ribs** (11-12): don't attach, no costal cartilage
- Head, Articular facets (2), neck, tubercle (transverse process connection), body, angle, costal groove
- Atypical **Ribs 1 and 2:** **shorter** and wider, head of **Rib 1** attaches to only **one** vertebrae (T1). T1, T10-12 has **full facet** (not demifacet)
- Atypical **Ribs 10-12:** attach to **one** vertebral body, 11 and 12 floating - 11 and 12 no articulation with **transverse facet**.
- **Costovertebral joint:** rib + 2 vertebral bodies (demifacets)
- **Costotransverse joint:** costal tubercle, transverse facet (not 11-12)
- Movement: increase width, increase anteriorly

Pelvis (3 bones) - Ilium, Ischium, Pubis

- **Ilium** (superior hip), **pubis** (medial), **ischium** (lateral, posterior)
- All 3 bones meet at hip socket - **acetabulum**
- **Iliac crest, ischial tuberosity** (sit bone), **pubic symphysis** (connect left and right pubis, cartilage)
- **Inguinal ligament**: ligament from iliac crest to pubis

Muscles of the Trunk

Concentric: muscles shorter. **Eccentric**: muscles lengthen

Isometric: muscle same length

Intrinsic: coming from inside **Extrinsic**: coming from outside

Extrinsic Back Muscles

- **Thoracolumbar fascia**: overlies **intrinsic** back muscles. Site of attachment for **extrinsic** back muscles
- **Intrinsic back muscles** span one vertebrae to another. Act upon vertebral column: posture, rotation, extension/flexion. **3** layers
- Superficial Layer (1): **inferomedial** to **superolateral** orientation
 - **Splenius**: **extends** head/neck, **laterally flexes** head/neck
 - **Erector spinae** (3 muscles): **extension** of spine, **lateral flexion**
 - **Spinalis**: spinous process to spinous process (medial)
 - **Longissimus** (middle). **Iliocostalis**: iliac crest to ribs (lateral)
- Intermediate Layer (2): **inferolateral** to **superomedial** orientation
 - **Transversospinales**: transverse process to spinous process
 - **Semispinalis**: posture, extension/lateral flexion head/neck
 - **Multifidus**: core stabiliser thoracolumbar vertebrae
 - **Rotatores**
- Deep Layer (3): **vertical** fibre orientation.
 - **Segmentals interspinalis**: adjacent spinous processes
 - **Intertransversari**: adjacent transverse processes. Posture

Thoracic Wall Muscles

- **External Intercostals**: **superolateral** to **inferomedial** orientation (elevate ribs)
- **Internal Intercostals**: **inferolateral** to **superomedial** orientation (depress ribs)
- **Innermost Intercostals**: **inferolateral** to **superomedial** orientation (**one** intercostal space) (depress ribs)
- **Subcostals**: posterior thoracic wall (2-3 ribs) (depress ribs) **inferomedial** to **superolateral**
- Transversus Thoracis: lateral orientation from internal aspect of sternum, anterior thoracic wall. Depression of ribs
- **Intercostal nerves**: superior to inferior: **vein, artery, nerve**
- Run along costal grooves, **11 intercostal** nerves (ventral rami) **1 subcostal** nerve (under 12th rib)
- **Intercostal arteries**: two sets, **anterior intercostal arteries** (arise from internal thoracic artery) **posterior intercostal artery** (aorta)
- **Intercostal veins**: two sets, **anterior** (drain to internal thoracic veins) and **posterior** (drain to azygous (R)/hemiazygous (L) vein)

Anterolateral Abdominal Wall

- **Aponeuroses**: attach anteriorly, tendon sheets
- **Linea alba**: midline tendons seam (white line)
- **External oblique**: largest, superolateral to inferomedial orientation. Rotates torso contralaterally, laterally flexes trunk
- **Internal oblique**: smaller/thinner, inferolateral to superomedial orientation. Rotates torso ipsilaterally, lateral flexes trunk
- **Transversus Abdominis**: deepest, horizontally orientation.
- **Rectus Abdominis**: multi-bellied muscle separated by intermediate tendons, flexes lumbar spine. Linda semilunari at lateral border, linea alba at medial border
- **Rectus Sheath**: rectus abdominis enveloped by aponeuroses of external, internal obliques, transverses abdominis

Arcuate Line

- **Superior**: aponeuroses distributed anterior and posterior. Transversus abdominis aponeurosis courses posterior to rectus
- **Inferior**: all aponeuroses course anterior to rectus abdomens

Posterior Abdominal Wall Muscles

- **Psoas major**: attached to lumbar spine body, flexes hip
- **Quadratus Lumborum**: lateral to psoas major, 12th rib and iliac crest

Pelvic Floor (4) - puborectalis, pubococcygeus, iliococcygeus, coccygeus

- Muscle floor perforated with 2 apertures (hole) - **urogenital/rectal hiatus**
- Always contracted. Urinary and faecal continence
- **Levator Ani**: elevate anus - **puborectalis, pubococcygeus, iliococcygeus**
- **Coccygeus**: not levator ani. Flexes coccyx

Respiratory System (W3)

Diaphragm

- Thoracic cavity: Mediastinum, pleural cavity, pericardial cavity, diaphragm
- Origin: xiphoid process, inferior costal cartilages, spans L1-L3
 - Converge to central tendon (oesophageal hiatus (T10) and caval opening (T8) - IVC, aortic hiatus (T12) - anterior to spine
 - Caval opening right to aortic hiatus
 - Median, medial, lateral arcuate ligament

Median Arcuate Ligament

- Two crura: left and right crus
- Left: left of oesophagus, left of aorta
- Right: goes around oesophagus, right side of aorta. Connects to duodenum. Holds oesophagus shut. Prevent acid reflux

Phrenic nerves

- Between each lung, on each side of heart runs phrenic nerve
- Origin from C3-C5 in neck, runs anteriorly to anterior scalene muscle and 1st rib, between pleural cavity and mediastinum
- Innervates diaphragm, contraction depresses diaphragm

Asymmetrical Growth Lungs

- Primary bronchi (R and L). Secondary bronchi (each lobe) - 3 on right (superior, middle, inferior), 2 on left (superior, inferior)

Larynx - opening to respiratory tract

- **Hyoid bone**: doesn't articulate with other bones(C shaped) Superior
- **Thyroid cartilage**: anterior aspect, adams apple - no posterior
 - **Inferior horn** of thyroid cartilage: connects to **cricoid cartilage**
- **Thyrohyoid membrane**: ligament between hyoid bone and thyroid cartilage - no posterior side. Opening for nerves, veins, arteries etc.
- **Cricoid cartilage**: inferior to thyroid, taller posterior, short anterior, ring shaped. ONLY CARTILAGE WITH POSTERIOR
- **Cricothyroid membrane**: between cricoid and thyroid cartilages.
- **Tracheal rings**: inferior to cricoid, C-shaped, no posterior
- **Epiglottis**: connected to thyroid cartilage, bends posteriorly when swallowing. Sits through roof of larynx, above hyoid bone
- **Arytenoid cartilage**: posterior to thyroid
- **Corniculate cartilage**: posterior to thyroid, superior to arytenoid
- **Vocal ligament**: between arytenoid and corniculate and thyroid
- Piriform recess, arytenoid cartilage, aryepiglottic fold

Laryngeal Muscles and Nerves

- Arytenoid cartilage bulge, epiglottis, piriform recess, vocal ligament, aryepiglottic fold
- Extrinsic muscles pull thyroid cartilage anteriorly
- Hole between vocal cords is called rima glottidis
- Vagus nerve, **superior laryngeal nerve** (sensory above vocal cords, motor to extrinsic muscles)
 - **Internal laryngeal nerve**: thyrohyoid membrane, sensory action superior to vocal cords. Through thyrohyoid membrane hole
 - **External laryngeal nerve**: extrinsic muscles
 - **Recurrent laryngeal nerve**: continued into thorax, **loops** around right subclavian artery, **loops** around arch of aorta. Then goes back up towards inferior aspect of larynx. **Intrinsic muscles, sensory inferior to vocal cords**

Lungs - 2 separate pleural cavities

- **Apex**: superior aspect of lung **Base**: inferior aspect of lung
- **Right lung**: inferior, middle and superior lobe. Oblique and horizontal fissure
- **Left lung**: inferior and superior lobe. Oblique fissure only. Cardiac notch and lingula (extension of superior lobe).
- Superior lobe sits anteriorly, inferior lobe sits posteriorly
- **Hilum**: where bronchi, arteries, veins, nerves exit/enter lung
- Pleura: serous membrane. Airtight. Two membranes,
- **Visceral pleura**: covers lungs. **Parietal pleura**: attached to chest wall. **Pleural space** between layers is airtight. **Pleural fluid** in pleural space
- Relaxed inhalation: diaphragm
- Forced inhalation: intercostal muscles (**outwards**), scalene muscles (**superiorly**), serratus posterior superior (**superiorly**), serratus posterior inferior (**inferiorly**)

Cardiovascular System (W4)

Mediastinum - cavity between pleural sacs

- Transverse thoracic plane: T4/T5. **Superior mediastinum** above, **inferior mediastinum** below (**anterior**, **middle** and **posterior** divisions)
- **Superior mediastinum**: Manubrium, T1-4, anterior part contains thymus. Veins: superior vena cava, right brachiocephalic vein, left brachiocephalic vein, arch of azygos vein (posterior)
Arteries: arch of aorta, brachiocephalic trunk, left common carotid artery, left subclavian artery.
Nerves: right vagus nerve (anterior to right subclavian artery), left vagus nerve (pass over aorta), left/right recurrent laryngeal nerve, phrenic nerve. Oesophagus, trachea, thoracic duct
- **Anterior mediastinum**: between body of sternum and pericardium.
- **Middle mediastinum**: contains pericardial sac and heart, between lung and hila. Superior to diaphragm. main bronchi, pulmonary artery, superior pulmonary vein inferior pulmonary vein, lymph nodes, phrenic nerve
- **Posterior mediastinum**: T5-12, one half posterior to middle, one half posterior to diaphragm. Descending aorta, azygous veins, hemiazygous vein, oesophagus anterior to aorta

Aorta

- **Ascending aorta**: two branches: right and left coronary artery.
- **Aortic arch**: left side of trachea, 3 branches: brachiocephalic trunk (divides into right common carotid and right subclavian artery), left common carotid artery, left subclavian artery
- **Descending aorta**: 3rd to 11th posterior intercostal arteries. Bronchial artery, oesophageal artery, superior phrenic artery.

Pericardium - sac that surrounds middle mediastinum

- Parietal pleura: lines internal thoracic wall. Visceral pleura: covers lungs
- Pericardium is fibrous serous membrane, several layers
- **Fibrous pericardium** (tough, inelastic), **parietal** serous pericardium, pericardial space, **visceral** serous pericardium, myocardium, endocardium
- Fibrous pericardium is continuous with central tendon of diaphragm
- Right and left phrenic nerve run on sides of fibrous pericardium. Provide sensation to fibrous pericardium, parietal serous pericardium.
- Pericardial sac: fibrous pericardium connects to central tendon, visceral and parietal serous pericardium reflect here (same but form two layers). Reflection occurs for veins and arteries.

Heart - between sternum and 4 T vertebrae. Apex located anterior inferiorly

- Anterior surface: sternocostal surface. Inferior surface: diaphragmatic surface. Right pulmonary surface. Left pulmonary surface
- Right border, inferior border, left border, superior border
- Anterior interventricular sulcus
- Pulmonary trunk (anterior), aorta posterior to pulmonary trunk

Coronary Arteries

- Left and right coronary artery from ascending aorta. Encircle the heart in **atrioventricular grooves**. Anterior branch occupies **anterior interventricular sulcus** & posterior branch occupies **posterior interventricular sulcus**
- Right coronary artery (RCA):
 - **Right conus**
 - **Sinoatrial nodal** (supplies SA node)
 - **Right atrial branch** (supplies right atrium)
 - **Right marginal branch** (supplies part of right ventricle, apex)
 - RCA continues in atrioventricular groove to posterior aspect of heart, supplies **atrioventricular nodal branch**
 - RCA on posterior aspect 90 degree turn downwards to form **posterior interventricular branch** towards apex
 - Posterior interventricular branch forms small **septal (posterior) branches**
- Left coronary artery (LCA):
 - **Anterior interventricular branch**
 - **Circumflex branch** (moves to lateral and posterior side of heart)
 - Anterior interventricular branch produces **septal (anterior) branch** - branches off to right side, septum. Also Produces **left diagonal branch**
 - Circumflex produces **left marginal branch**, supply left ventricle. Also goes posterior in atrioventricular groove, supply posterior left ventricle
- Cardiac veins
 - **Coronary sinus**: runs left to right in **atrioventricular groove posteriorly**. Drains into right atrium
 - **Great cardiac vein**. Alongside **anterior interventricular branch** of LCA. Connects to coronary sinus on left side
 - **Middle cardiac vein**. Alongside **posterior interventricular branch**. Connects to coronary sinus inferiorly
 - **Small cardiac vein**. Alongside **posterior RCA** in **atrioventricular groove**. Connects to coronary sinus from right side.

Right Atrium

- Opening of coronary sinus, opening of IVC and SVC
- Right auricle, **pectinate muscles** on anterior wall (force of contraction).
Crista terminalis (conducts impulses)
- **Interatrial septum**, separate right and left atrium
- **Tricuspid valve**: connects RA to RV (Anterior, Septal and Posterior)
- Mitral valve (LA): Anterior and posterior cusp
- **Chordae tendinae** (connect cusp to muscles) **Papillary muscles** (open and close cusps)

Right Ventricle

- **Chordae tendinae** (attach to edge of cusp) **Papillary muscles** (connects chord tendinae to pectinate muscles)
- **Interventricular septum**
- **Trabeculae carnae**: muscles on inner wall of ventricles
- Pectinate muscles = atrium. Trabecular carnae = ventricles
- **Conus arteriosus**: smooth surface at pulmonary valve
- **Pulmonary valve**: semilunar valve (3): anterior, right and left cusp
- **Aortic valve**: semilunar valve (3): left, right and posterior cusp

Left atrium

- **Left auricle** with **pectinate muscles**. **Interatrial septum**
- **Left atrioventricular orifice**. Pulmonary vein orifices (opening)
- **Anterior** and **posterior** cusps of **mitral valve**. **Chordae tendinae** and **papillary muscles**

Left ventricle

- **Trabeculae carnae**
- **Aortic valve** (3 cusps) - left, right, posterior cusps
- Smooth section approaching aortic valve: **aortic vestibule**
- Significantly thicker wall. Interventricular septum bulges into right ventricle
- Aortic valve: left and right coronary artery ostium, opening of RCA/LCA

Conducting System

- Sinoatrial (SA) Node: pacemaker, wall of right atrium
- Atrioventricular (AV) node: slow excitation of ventricles
- Atrioventricular bundle of His: bridges atrial and ventricular myocardium
- Right bundle branch: under endocardium of right ventricle
- Left bundle branch: under endocardium of left ventricle
- Purkinje fibres: conduct excitation to papillary and ventricular muscles
- **Cardiac plexus**: sympathetic supply from T1-T5. Located on aortic arch
 - Vagus nerve: parasympathetic actions