MEDICAL EDUCATION RESOURCE

Sternum & Vertebral Column

Sternum

The **sternum** is a **flat bone** forming the **anterior median wall of the thorax**, resembling a **short sword**.
It consists of **three parts**:

1. **Manubrium (handle)**
2. **Body (blade)**
3. **Xiphoid process (point)**

The sternum measures about **17 cm in length**, and is **longer in males** than in females.

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1. Manubrium

- **Shape:** Quadrilateral, thick, and strong.
- **Surfaces:**
  - **Anterior surface:** Convex side-to-side, concave vertically.
  - **Posterior surface:** Concave, forming anterior boundary of **superior mediastinum**.
- **Borders:**
  - **Superior border:** Has **suprasternal (jugular) notch** medially and **clavicular notches** laterally, articulating with **clavicles** at the **sternoclavicular joints**.

- **Inferior border:** Joins body of sternum at the **sternal angle (Angle of Louis)**—a palpable ridge where several important structures lie.

Structures at the Sternal Angle:

- Formation of **cardiac plexus**
- **Upper limit of heart base**
- **Beginning and end of aortic arch**
- **Bifurcation of trachea**

Attachments:

- **Anterior surface:** Pectoralis major, sternal head of sternocleidomastoid
- **Posterior surface:** Sternohyoid (upper part), Sternothyroid (lower part)
- **Suprasternal notch:** Interclavicular ligament, cervical fascia

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2. Body of Sternum

- **Longer and thinner** than manubrium; widest near the **fifth costal cartilage**.
- **Surfaces:**
  - **Anterior:** Nearly flat with **transverse ridges**, marking fusion of four **sternebrae**.
  - **Posterior:** Slightly concave.
- **Lateral borders:** Articulate with 2nd–7th costal cartilages.

- **Upper end:** Joins manubrium (secondary cartilaginous joint).
- **Lower end:** Joins xiphisternum (primary cartilaginous joint).

Attachments:

- **Anterior surface:** Pectoralis major
- **Posterior surface:** Sternocostalis
- **Relations:**
  - Right side ? right lung and pleura
  - Left side ? upper part related to left lung and pleura, lower part to pericardium

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3. Xiphoid Process (Xiphisternum)

- Smallest and most variable part of sternum—may be **bifid** or **perforated**.
- **Initially cartilaginous**, later ossifies near its upper end.
- Lies in the **floor of epigastric fossa**.

Attachments:

- **Anterior:** Rectus abdominis, external and internal oblique aponeuroses
- **Posterior:** Diaphragm; related to anterior surface of liver
- **Lateral:** Internal oblique and transversus abdominis aponeuroses

- **Upper end:** Articulates with body (primary cartilaginous joint)
- **Lower end:** Attached to linea alba

Development and Ossification

- Develops from **two sternal plates** (right and left) that **fuse in midline**, proceeding **cranio-caudally**.
- **Manubrium:** 2 ossification centers (5th month intrauterine life).
- **Body:**
  - 1st & 2nd sternebrae ? single center each (5th month).
  - 3rd & 4th sternebrae ? paired centers (5th–6th months).
  - Fusion occurs **from below upward during puberty**, completed by **25 years**.
- **Xiphoid process:** Center appears in **3rd year** or later; fuses with body at **around 40 years**.
- **Manubriosternal joint:** Secondary cartilaginous joint, usually persists for life.

Clinical Anatomy

- **Bone marrow biopsy:**
  - Commonly performed through **manubriosternal puncture** (upper half of manubrium) to avoid injury to the **aortic arch** behind its lower part.
- **Movements:**

- Slight movement at the **manubriosternal joint** allows rib elevation during breathing.

- **Funnel chest (Pectus excavatum):**
  - Depression of sternum.
- **Ectopia cordis:**
  - Heart lies exposed due to **non-fusion of sternal plates**.
- **Sternal foramina or bifid xiphoid:**
  - Result from **partial fusion defects**.
- **Fracture of sternum:**
  - Usually due to **indirect trauma**; can occur at sternal angle or body.

Summary Table

PART	FEATURES	ATTACHMENTS / RELATIONS	CLINICAL POINTS
Manubrium	Thick, strong, has jugular notch	SCM, pectoralis major, sternohyoid, sternothyroid	Sternal angle – tracheal bifurcation, aortic arch
Body	4 sternebrae fused	Pectoralis major, sternocostalis	Bone marrow biopsy site

PART	FEATURES	ATTACHMENTS / RELATIONS	CLINICAL POINTS
Xiphoid process	Smallest, variable	Rectus abdominis, diaphragm	Bifid or perforated, site for CPR landmark
Joint	Manubriosternal (secondary cartilaginous)	—	Movement in respiration

Vertebral Column as a Whole

- Also called the **spine** or **backbone**, it forms the **central axis of the body** and supports **body weight**, transmitting it to the lower limbs.
- Composed of **33 vertebrae**:
    - **7 cervical**
    - **12 thoracic**
    - **5 lumbar**
    - **5 sacral (fused)**
    - **4 coccygeal (fused)**
- The **movable (true) vertebrae** are cervical, thoracic, and lumbar (24 total).
- The **fixed (false) vertebrae** form the **sacrum and coccyx**.

- Average length: **70 cm in males**, **60 cm in females**.
- **Intervertebral discs** contribute about **1/5th of total length**.

Curvatures of Vertebral Column

- **Primary curves** (present at birth):
  - **Thoracic** and **sacral** — concave forwards.
- **Secondary curves** (develop after birth):
  - **Cervical:** appears at 4–5 months when the infant lifts the head.
  - **Lumbar:** appears at 12–18 months when the child stands upright.
- **Functional significance:**
  - Curvatures increase **elasticity and shock absorption**.
  - The presence of multiple curves provides **greater resistance** to vertical compression.
- **Lateral curvature:** slight curve in thoracic region concave to the **left** (due to right-hand dominance and aortic pressure).

Parts of a Typical Vertebra

- **Body:** Weight-bearing, anterior part.
- **Vertebral arch:** Formed by pedicles and laminae.

- **Vertebral foramen:** Lies between body and arch; forms **vertebral canal** for spinal cord.
- **Processes:**
    - **Spinous process** (posterior)
    - **Transverse processes** (2)
    - **Articular processes** (2 superior, 2 inferior)

Intervertebral Discs

- **Type:** Secondary cartilaginous joint (symphysis).
- **Structure:**
    - **Nucleus pulposus:** Soft, gelatinous, central part—acts as a **shock absorber**.
    - **Annulus fibrosus:** Peripheral part of **fibrocartilage**, arranged in concentric lamellae.
- **Thickness:** Greatest in lumbar, least in upper thoracic region.
- Allow **flexibility and slight movement** between vertebrae.
- Account for **height loss with age** due to decreased elasticity.

Ossification

Each vertebra ossifies from **3 primary centers** and **5 secondary centers**.

Primary Centers (appear in fetal life):

1. **One for body** (centrum).
2. **Two for neural arches** (one on each side).
    - The neural arches fuse with the body by **3–6 years**.

Secondary Centers (appear during puberty):

1. **One for the tip of the spinous process.**
2. **One for each transverse process (two total).**
3. **Two for annular epiphyses**—upper and lower rims of body.
    - All fuse by **25 years of age**.

Exceptions:

- **Atlas (C1):** No body; represented by **anterior arch** ossification.
- **Axis (C2):** Has **odontoid process (dens)** derived from the body of atlas.
- **Sacrum:** Five sacral vertebrae fuse by **25–30 years**.
- **Coccyx:** Fusion occurs progressively till **adulthood**.

Clinical Anatomy

- **Herniated (slipped) disc:**
    - Protrusion of nucleus pulposus through annulus fibrosus compresses spinal nerves.

- Common sites: **L4–L5** and **L5–S1**.

- **Scoliosis:** Lateral curvature of spine.
- **Kyphosis:** Exaggerated thoracic curvature (hunchback).
- **Lordosis:** Exaggerated lumbar curvature (swayback).
- **Spina bifida:**
  - Failure of fusion of neural arches; spinal cord may be exposed (meningomyelocele).
- **Spondylolisthesis:** Forward slipping of one vertebra over another, usually **L5 over S1**.
- **Intervertebral disc degeneration:** Leads to reduction in height with aging.
- **Tuberculosis of spine (Pott's disease):**
  - Destruction of vertebral bodies, producing **gibbus deformity** (acute angular kyphosis).

Summary Table

FEATURE	DESCRIPTION
Total vertebrae	33 (7C, 12T, 5L, 5S, 4C)
Movable vertebrae	24 (C, T, L)
Primary curves	Thoracic, Sacral

FEATURE	DESCRIPTION
Secondary curves	Cervical, Lumbar
Type of joint	Symphysis (secondary cartilaginous)
Ossification	3 primary + 5 secondary centers
Common disc prolapse	L4–L5, L5–S1
Common anomalies	Scoliosis, Kyphosis, Spina bifida