Spine and vertebra
RIBS
STERNUM

Danil Hammoudi.MD
Axial v. Appendicular Skeleton

• Axial Skeleton
  – Skull
  – Vertebral column
  – Thoracic cage
    • Ribs and sternum

• Appendicular Skeleton
  – Bones of the upper and lower limbs
  – Plus, pectoral and pelvic girdles
The spine, or vertebral column, is composed of 5 main segments:

- **the cervical,**
- **the thoracic,**
- **and lumbar curvatures,**
- **the sacrum,**
- **and the coccyx.**

Each of these curvatures is composed of individual vertebrae, which provide structural support and protection for the spinal cord.

- There are 24 movable vertebrae in the spine;
  - 7 in the cervical curvature,
  - 12 in the thoracic curvature,
  - 5 in the lumbar curvature.

- Additionally, the sacrum consists of 5 fused vertebrae
  - the coccyx is composed of three to five fused vertebrae.
The spine provides attachment for our ribs, muscles and ligaments which make up the trunk.

It is divided into 3 regions:

- Neck (cervical)                  7 vertebrae
- Thoracic                        12 vertebrae
- Lumbar                          5 vertebrae
The **vertebral column** (also called the backbone, spine, or spinal column) consists of a series of 33 irregularly shaped bones, called vertebrae. These 33 bones are divided into five categories depending on where they are located in the backbone.

The first seven vertebrae are called the **cervical vertebrae**. Located at the top of the spinal column, these bones form a flexible framework for the neck and support the head. The first cervical vertebra is called the atlas and the second is called the axis. The atlas' shape allows the head to nod "yes" and the axis' shape allows the head to shake "no".

The next twelve vertebrae are called the **thoracic vertebrae**. These bones move with the ribs to form the rear anchor of the rib cage. Thoracic vertebrae are larger than cervical vertebrae and increase in size from top to bottom.

After the thoracic vertebrae, come the **lumbar vertebrae**. These five bones are the largest vertebrae in the spinal column. These vertebrae support most of the body's weight and are attached to many of the back muscles.

The **sacrum** is a triangular bone located just below the lumbar vertebrae. It consists of four or five sacral vertebrae in a child, which become fused into a single bone after age 26. The sacrum forms the back wall of the pelvic girdle and moves with it.

The bottom of the spinal column is called the **coccyx** or tailbone. It consists of 3-5 bones that are fused together in an adult. Many muscles connect to the coccyx.
These bones compose the vertebral column, resulting in a total of 26 movable parts in an adult. In between the vertebrae are intervertebral discs made of fibrous cartilage that act as shock absorbers and allow the back to move. As a person ages, these discs compress and shrink, resulting in a distinct loss of height (generally between 0.5 and 2.0 cm) between the ages of 50 and 55.

When looked at from the side, the spine forms four curves.
- These curves are called the cervical, thoracic, lumbar, and pelvic curves.
- The cervical curve is located at the top of the spine and is composed of cervical vertebrae. Next come the thoracic and lumbar curves composed of thoracic and lumbar vertebrae respectively.
- The final curve called the pelvic or sacral curve is formed by the sacrum and coccyx. These curves allow human beings to stand upright and help to maintain the balance of the upper body. The cervical and lumbar curves are not present in an infant. The cervical curves forms around the age of 3 months when an infant begins to hold its head up and the lumbar curve develops when a child begins to walk.

In addition to allowing humans to stand upright and maintain their balance, the vertebral column serves several other important functions. It helps to support the head and arms, while permitting freedom of movement. It also provides attachment for many muscles, the ribs, and some of the organs and protects the spinal cord, which controls most bodily functions.
The cervical spine is further divided into two parts:

- the upper cervical region (C1 and C2),
- the lower cervical region (C3 through C7).

- C1 is termed the Atlas and C2 the Axis.
- The Occiput (CO), also known as the Occipital Bone, is a flat bone that forms the back of the head.
<table>
<thead>
<tr>
<th>Term</th>
<th># of Vertebrae</th>
<th>Body Area</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical</td>
<td>7</td>
<td>Neck</td>
<td>C1 – C7</td>
</tr>
<tr>
<td>Thoracic</td>
<td>12</td>
<td>Chest</td>
<td>T1 – T12</td>
</tr>
<tr>
<td>Lumbar</td>
<td>5 or 6</td>
<td>Low Back</td>
<td>L1 – L5</td>
</tr>
<tr>
<td>Sacrum</td>
<td>5 (fused)</td>
<td>Pelvis</td>
<td>S1 – S5</td>
</tr>
<tr>
<td>Coccyx</td>
<td>3</td>
<td>Tailbone</td>
<td>None</td>
</tr>
</tbody>
</table>
| Protection                           | • Spinal Cord and Nerve Roots  
<table>
<thead>
<tr>
<th></th>
<th>• Many internal organs</th>
</tr>
</thead>
</table>
| Base for Attachment                | • Ligaments                   
|                                    | • Tendons                     
|                                    | • Muscles                     |
| Structural Support                 | • Head, shoulders, chest      
|                                    | • Connects upper and lower body 
|                                    | • Balance and weight distribution |
| Flexibility and Mobility           | • Flexion (forward bending)   
|                                    | • Extension (backward bending) 
|                                    | • Side bending (left and right) 
|                                    | • Rotation (left and right)    
|                                    | • Combination of above        |
| Other                              | • Bones produce red blood cells |
|                                    | • Mineral storage             |
1. 1st Lumbar vertebra
2. 2nd Lumbar vertebra
3. 3rd Lumbar vertebra
4. 4th Lumbar vertebra
5. 5th Lumbar vertebra
6. T12
7. Twelfth rib
8. Sacroiliac joint
9. Sacrum
10. Sacral foramen
11. Ilium
12. Pelvic brim
13. Superior ramus of pubic bone
14. Pubic symphysis
ATLAS (1ST CERVICAL VERTEBRA)   AXIS (2ND CERVICAL VERTEBRA) TYPICAL 3RD - 7TH CERVICAL VERTEBRA THORACIC VERTEBRA LUMBAR VERTEBRA SACRUM & COCCYX
Atlas (C1)
The Atlas is the first cervical vertebra and therefore abbreviated C1.

This vertebra supports the skull.

Its appearance is different from the other spinal vertebrae.

The atlas is a ring of bone made up of two lateral masses joined at the front and back by the anterior arch and the posterior arch.

Axis (C2)
The Axis is the second cervical vertebra or C2.

It is a blunt tooth–like process that projects upward.

It is also referred to as the ‘dens’ (Latin for ‘tooth’) or odontoid process.

The dens provides a type of pivot and collar allowing the head and atlas to rotate around the dens.
ATLAS VERTEBRA

Neural arch

Transverse process

Canal for odontoid peg

Ventral tubercle

Facet for articulation with the skull

Ligament

Neural canal

Vertebrarterial canal

Transverse process

Facet for articulation with the axis

Ventral tubercle
**Axis**

- **Atlas**: no centrum, articular surface for odontoid process, no spinous process
- **Axis**: odontoid process (dens)
CERVICAL
THORACIC

Unique thoracic features: demifacets for articulation with rib head, seen from side (except for 11th and 12th.), articular facets on transverse processes (for rib tubercle) and long delicate spinous processes.
centrum, neural arch, vertebral foramen, pedicle, spinous process, lamina, superior articular processes, transverse process
5th thoracic vertebra with rib. Anterior aspect.
Lumbar vertebra. Anterior aspect (above). Left lateral aspect (below).
Sacrum

- 5 vertebrae fuse together to form a single bone
- Articulates with:
  - L5 (through SAP)
  - Coccyx
- Functions in weight transfer
- Anterior surface
  - Sacral promontory
  - Transverse ridges
  - Anterior sacral foramina
- Posterior surface
  - Median and lateral sacral crest
  - Posterior sacral foramen
heavy centra,
broad heavy spinous process,
transverse process lacks facets
SACRUM COCCYX
SACRUM

(posterior view):

- dorsal sacral foramina,
- superior articular facet,
- auricular surface (on sides, for os coxa),
- (ala),
- median sacral crest,
- sacral canal,
- sacral hiatus.
1. Promontory
2. Transverse Ridges
3. Coccyx
4. Body of Sacrum
5. Sacral Canal
6. Superior Articular Surface
7. Median Sacral Crest
8. Sacrum to Ilium Articular Surface
9. Dorsal Sacral Foramina
10. Sacral hiatus
The sacrum articulates with four bones: the last lumbar vertebra above, the coccyx below, and the hip bone on either side. Although in most people the sacro-iliac joints are tightly bound and immobile, some are able to rotate the sacrum forward a few degrees vis-à-vis the ilia. This motion is sometimes called "nutation", and the reverse motion "counter-nutation"
• The pelvic surface of sacrum is concave from above downward, and slightly so from side to side.
• The dorsal surface of sacrum is convex and narrower than the pelvic.
• The lateral surface of sacrum is broad above, but narrowed into a thin edge below.
• The base of the sacrum, which is broad and expanded, is directed upward and forward.
• The apex (apex oss. sacri) is directed downward, and presents an oval facet for articulation with the coccyx.
• The vertebral canal (canalis sacralis; sacral canal) runs throughout the greater part of the bone; above, it is triangular in form; below, its posterior wall is incomplete, from the non-development of the laminae and spinous processes. It lodges the sacral nerves, and its walls are perforated by the anterior and posterior sacral foramina through which these nerves pass out. For Hindus and Sahaja Yogis the kundalini resides in the sacrum bone in a dormant state.
Coccyx (3-5 fused)

- “Tailbone”
- Useless bone………
  - But painful!
- Slight support to pelvic organs and ligament attachment
- Articulates superiorly with sacrum
- Anterior concave
- Posterior convex
The Bony Thorax

- Sternum (3 parts)
- Ribs
- Clavicle
- Scapula
- Vertebrae (5 parts)
2. Thoracic Cage

- **Borders:**
  - Thoracic vertebrae posteriorly
  - Ribs laterally
  - Sternum and costal cartilages anteriorly

- **Forms protective cage @ heart, lungs, and other organs**

- **Composed of:**
  - Sternum
  - Ribs
RIBS

The Ribs

viewed from the right side
Thoracic Cage - Ribs

2 pairs
- True ribs
  - Superior 7 pairs that attach directly to sternum by CC
- False ribs (8-12)
  - Inferior 4 pairs (8-10) and attach indirectly to sternum
  - Floating ribs
    - Ribs 11 and 12 and have no anterior attachments (muscles)
Ribs

- Typical ribs
  - # 2-9
- Atypical ribs
  - # 1, 10-12
- Increase in length from 1-7
- Decrease in length from 8-12
- Costal margin
Rib Anatomy – Typical Ribs

• Shaft
  – costal groove at inferior border

• Head
  – Articulates with 2 demifacets

• Neck

• Tubercle

• Angle

• Subcostal groove
Anatomy – Typical Ribs

- **Dorsal attachment**
  - Head of Rib → 2 Demifacets
    - Superior demifacet
    - Inferior demifacet of vertebra above it
    - Intervertebral disc
  - Tubercle of Rib
    - Articulates with Transverse Costal Facet (Thoracic vertebra)
    - Ex. Rib #4 articulates with Superior Demifacet and Transverse Costal Facet of T4 & Inferior demifacet of T3

- **Ventral attachment**
  - Costal cartilage
Rib Anatomy – Atypical Ribs

- #1 – flat and broad, supports subclavian vessels
- #1, and 10-12 – articulate with only 1 vertebral body
- #11 and 12 – do not articulate with a vertebral transverse process
The rib cage is joined to the thoracic vertebrae.

At T11 and T12, the ribs do not attach and are so called "floating ribs."

The thoracic spine's range of motion is limited due to the many rib/vertebrae connections and spinous processes.
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Articular Facet of Rib</td>
</tr>
<tr>
<td>2</td>
<td>Interarticular Crest</td>
</tr>
<tr>
<td>3</td>
<td>Neck</td>
</tr>
<tr>
<td>4</td>
<td>Articular Portion of Tubercle</td>
</tr>
<tr>
<td>5</td>
<td>Nonarticular Portion of Tubercle</td>
</tr>
<tr>
<td>6</td>
<td>Angle of Rib</td>
</tr>
<tr>
<td>7</td>
<td>Costal Groove</td>
</tr>
<tr>
<td>8</td>
<td>Body of Rib</td>
</tr>
<tr>
<td>9</td>
<td>Articular Facet of Transverse Process</td>
</tr>
<tr>
<td>10</td>
<td>Transverse Process</td>
</tr>
<tr>
<td>11</td>
<td>Spinous Process</td>
</tr>
<tr>
<td>12</td>
<td>Lamina</td>
</tr>
<tr>
<td>13</td>
<td>Vertebral Foramen</td>
</tr>
</tbody>
</table>
Peculiar Ribs.—The first, second, tenth, eleventh, and twelfth ribs present certain variations.

The first rib is the most curved and usually the shortest of all the ribs.
The ribs are thin, flat, curved bones that form a protective cage around the organs in the upper body. They are comprised 24 bones arranged in 12 pairs.

These bones are divided into three categories:

• The first seven bones are called the true ribs. These bones are connected to the spine (the backbone) in back. In the front, the true ribs are connected directly to the breastbone or sternum by strips of cartilage called the costal cartilage.

• The next three pairs of bones are called false ribs. These bones are slightly shorter than the true ribs and are connected to the spine in back. However, instead of being attached directly to the sternum in front, the false ribs are attached to the lowest true rib.

• The last two sets of rib bones are called floating ribs. Floating ribs are smaller than both the true ribs and the false ribs. They are attached to the spine at the back, but are not connected to anything in the front.

• The ribs form a kind of cage that encloses the upper body. They give the chest its familiar shape.

• The ribs serve several important purposes. They protect the heart and lungs from injuries and shocks that might damage them. Ribs also protect parts of the stomach, spleen, and kidneys. The ribs help you to breathe. As you inhale, the muscles in between the ribs lift the rib cage up, allowing the lungs to expand. When you exhale, the rib cage moves down again, squeezing the air out of your lungs.
Thoracic Cage - Sternum

- Lies in the anterior midline of the thorax
- Consists of 3 fused sternebrae (sections):
  - The manubrium
  - The body
  - The xiphoid process
**Sternum - Manubrium**

- “Handle”
- Connected to the first 2 ribs
- Clavicular notches articulate with clavicles (collarbone)
- Clavicular Articular facets

Costal Cartilage
Sternum - Body

- “Blade” or “gladiolus”
- Connects with ribs 2-7
- Sides are notched where it articulates with the costal cartilages
- 4 separate parts until after puberty
Sternum – Xiphoid Process

- “Tip”
- Cartilaginous (hyaline) that becomes bony over the years (@40)
- Partial attachment of many muscles
Sternum

3 major anatomical landmarks:

1. Jugular notch
   - Central indentation in manubrium

2. Sternal angle
   - Manubrium joins the body

3. Xiphisternal joint
   - Cartilaginous union between xiphoid process and body
The sternum or breastbone is a long, flat bone located in the center of the thorax (chest).
- It connects to the rib bones via cartilage, forming the rib cage with them, and thus helps to protect the lungs, heart and major blood vessels from physical trauma.
- The sternum is sometimes cut open (a median sternotomy) to gain access to the thoracic contents when performing cardiothoracic surgery.

The sternum is composed of three parts:
- The manubrium, also called the "handle", is located at the top of the sternum and moves slightly. It is connected to the first two ribs.
- The body, also called the "blade" or the "gladiolus", is located in the middle of the sternum and connects the third to seventh ribs directly and the eighth through tenth ribs indirectly.
- The xiphoid process, also called the "tip", is located on the bottom of the sternum. It is often cartilaginous (cartilage), but does become bony in later years.

These three segments of bone are usually fused in adults. The sternum serves an important function in the body. The ribs are connected to it by the costal cartilage. Without the sternum, there would be a hole in the bone structure in the middle of your chest, right above your heart and lungs. The sternum protects this vital area and completes the circle of the rib cage.
Articular surface for clavicle
Depression for 1st costal cartilage
Manubrium
Demifacets for 2nd costal cartilage
Facet for 3rd costal cartilage
Body
Facet for 4th costal cartilage
Facet for 5th costal cartilage
Facet for 6th costal cartilage
Facet for 7th costal cartilage
Xiphoid process
1. Rib
2. Sternum
3. Breast
4. Position of oblique fissure
5. Position of horizontal fissure