Vertebral Column

- Functions
- Regions
  - Cervical
  - Thoracic
  - Lumbar
  - Sacral
- Primary & secondary curvatures

There are three major functions of the vertebral column. First, it supports the entire upper body and holds it upright. Second, the vertebral foramina of the vertebrae completely surround and protect the spinal cord. Third, because the spinal cord is curved, it can act as a shock absorber and keeps the skull from being jarred when we walk and move.

The vertebral column is divided into four anatomical and functional regions: the top part (making up the next) consists of cervical vertebrae, the part that anchors the ribs are the thoracic vertebrae, the lower back are the lumbar vertebrae, and the lowest part, making up the back of the pelvic cavity, are the sacral vertebrae. In adults, each of these regions has a curve associated with it, as shown in the figure. When humans are born, only two of the curves, called the primary curvatures exist: the thoracic curvature and the sacral curvature. During the first several months of development, as babies learn to lift their heads and move their limbs, the secondary curvatures begin to form – the cervical curvature and the lumbar curvature.
The human vertebral column consists of 26 bones in all (the fetal vertebral column has more, but some of the vertebrae in the sacral region fuse during prenatal development).

The upper 7 vertebrae are the **cervical vertebrae**. They make up the neck and allow movement of the head and neck. We refer to these vertebrae with the letter C followed by a number (starting at the top). The first vertebra is C1, followed by C2, etc., down to C7.

The next 12 vertebrae are the **thoracic vertebrae**, which are numbered T1 through T12. Most of the thoracic vertebrae anchor the ribs posteriorly.

The last 5 of the individual vertebrae are the **lumbar vertebrae**, numbered L1 through L5. These bones are the largest of the vertebrae because they have to support the entire weight of the upper body.

Below L5 is the **sacrum**, a large wing-shaped bone that is actually 5 vertebrae that fused together before birth. At the base of the sacrum is the **coccyx** (the human tailbone). The coccyx is probably a vestigial form of a tail. In humans it serves no purpose.

The vertebrae are stacked up and are separated by discs of fibrocartilage called **intervertebral discs**. These discs cushion the vertebrae and keep them from banging or grinding against one another. The fibrocartilage is somewhat “stretchy,” which allows the vertebrae to tilt without tearing the cartilage. If the vertebrae twist or pull too much, it is still possible to tear an intervertebral disc, though, which is a condition called a herniated disc, or a “slipped disc.”
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• Generic vertebra

While vertebrae from different regions are anatomically different, most vertebrae share certain characteristics in common. These characteristics are identified in the figure. Note that the **spinous process** projects posteriorly (towards the back) and can be seen and felt through the skin in the back. They make the ridge of bumps you see down the midline of a person’s back. The spinal cord goes through the **vertebral foramina** of each vertebra, where it is well-protected from damage. You should memorize each of the regions shown in this figure.
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- Cervical vertebrae: axis & atlas (C₁ & C₂)

Because the cervical vertebrae are at the very top of the vertebral column, they 1) are the smallest of the vertebrae (they don’t have to support much weight) and, 2) have very large vertebral foramina. The spinal cord becomes narrower and narrower as it gets lower in the back because spinal nerves branch off at each vertebra.

The top two of the cervical vertebrae (C₁ and C₂) are special because they allow the head to move up and down as well as back and forth. They look different from the other cervical vertebrae. C₁, called the atlas, has no body and has very small spinous and transverse processes. It has very large fossae on its superior articular processes, though, where the occipital condyles at the base of the skull rest. The skull can move up and down (nodding “yes”) by moving in these fossae.

C₂, called the atlas, looks more like the rest of the vertebrae except that it has a process protruding from it that looks a lot like a trailer hitch. This process, called the dens, articulates with the atlas so that the atlas can pivot around it. This allows the head to pivot (turning your head “no”).
The rest of the cervical vertebrae (C3 to C7) have some unique characteristics that identify them as cervical vertebrae. The spinous process of most of these vertebrae are short and branch into two small processes at the end. The vertebral foramen is large and triangular. The biggest giveaway, though, is that the transverse processes have holes, called **transverse foramina**. No other vertebrae has these foramina (so, if you see a vertebra that has them, you know it’s cervical!). The large **vertebral arteries** run through the transverse foramina of the cervical vertebrae and carry a lot of the brain’s blood supply.

Although you can’t tell from this picture, the spinous process of the cervical vertebrae sticks almost straight back with very little angle. The bodies of the cervical vertebrae are fairly thin.
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• Thoracic vertebrae: T₁ to T₁₂
  – Transverse processes attach ribs

The thoracic vertebrae look very different from the cervical vertebrae. First, the transverse processes are longer and they do not have transverse foramina. The vertebral foramen is generally circular and is smaller. From above or below, the body of each thoracic vertebra is more-or-less heart-shaped. From the side, the biggest clue about the thoracic vertebrae is visible: the spinous processes make a sharp angle and point almost straight down. The bodies are thicker than the cervical vertebrae bodies. In a way, the thoracic vertebrae look sort of like giraffe heads from the side.
The lumbar vertebrae are distinctive as well. The spinous processes are short, stick straight back, and are wide (like an axe blade). The vertebral foramina are small and usually round. The bodies are very thick and block-like. From above or below, they are shaped sort of like kidney beans. From the side, the lumbar vertebrae look kind of like moose heads.
Can you categorize these vertebrae by type?


Upper-middle: Lumbar. Short, tall spinous process that projects straight back. Very thick body.

Upper-right: Lumbar. Short spinous process. Body is massive and kidney-shaped.

Lower-left: Thoracic. Heart-shaped body. Body has costal facets (which accepts the ends of ribs)

Lower-middle: Cervical. Triangular-shaped vertebral foramen. Transverse processes have transverse foramina. Forked spinous process.

The sacrum articulates with L5. The **sacral canal** is a large tunnel that carries the spinal cord deep into the sacrum, where it terminates at the **sacral hiatus**. The sacral canal is continuous with the vertebral foramina of the vertebrae. The sacrum is actually 5 vertebrae that fused together before birth. The fused spinous processes protrude posteriorly and form a ridge called the **median sacral crest**. Inferior to the sacrum is a pointed composite bone (composed of at least 3 fused vertebrae) called the **coccyx** (tailbone).
We’ll look at three spinal deformities. All of these deformities are *developmental* – they are not caused by trauma or bad posture.

**Scoliosis** is a deformity where the thoracic curvature of the spine deviates to the left or right. In minor cases, it’s not a problem and can be left untreated. In serious cases, though, this deformity can cause uneven shoulders or hips, headaches, problems with walking and problems with balance. In these cases, scoliosis can be corrected during development with a back brace or, in the most severe cases, by surgically implanting metal rods in the back as guides.
Kyphosis is a deformity in which the thoracic curvature is in-line with the rest of the spine, but it is curved more than usual. As with scoliosis, minor cases are no big deal, but major cases can cause problems with balance and walking. If treatment is indicated, a back brace or possibly surgery can correct the deformity.
**Lordosis** is similar to kyphosis, but the lumbar curvature is bent more than usual. As with the other deformities, minor lordosis is usually left untreated. Severe lordosis that interferes with balance or gait can be treated in the same ways as kyphosis can.
The sternum is a composite bone in the chest (the “breastbone”) composed of three fused bones. The most superior bone is the manubrium. At the superior end of the manubrium is an indentation called the jugular notch, which you should be able to easily feel on your own sternum. This is an important landmark for doctors because it’s usually in-line with where the left common carotid artery (one of the arteries supplying blood to the brain) branches off of the aorta. The middle, and largest, bone of the sternum is the body (or sternal body). It is separated from the manubrium by a slight bend called the sternal angle (you may be able to palpate this in your own chest, particularly if you hold your breath). The sternal angle allows the sternal body to hinge forward during inspiration. The most inferior, and smallest, bone of the sternum is the xiphoid process, which is attached to the body at the xiphisternal joint.
Humans have 12 pairs of ribs, which compose the rib cage. Each rib articulates posteriorly with a thoracic vertebra and most of them attach to the sternum (indirectly) anteriorly. The ribs are not directly attached to the sternum, though. Instead, long hyaline cartilage “rods” attach the anterior end of most ribs to the sternum. These costal cartilages allow the rib cage to expand during inspiration.

The first 7 pairs of ribs attach, via costal cartilages, directly to the sternum. These ribs are called **true ribs**. The lower 5 pairs connect only indirectly to the sternum (via branches of costal cartilage instead of directly across). These are called **false ribs**. The most inferior of the false ribs don’t articulate with the sternum at all! They are called **floating ribs** for this reason. (They’re still attached to thoracic vertebrae, though.)
In this figure, identify the true ribs, false ribs, floating ribs, manubrium, body, xiphoid process, jugular notch, sternal angle, and xiphisternal joint. Also, can you identify T1, L1 and T12?