# AXIAL / APPENDICULAR SKELETON

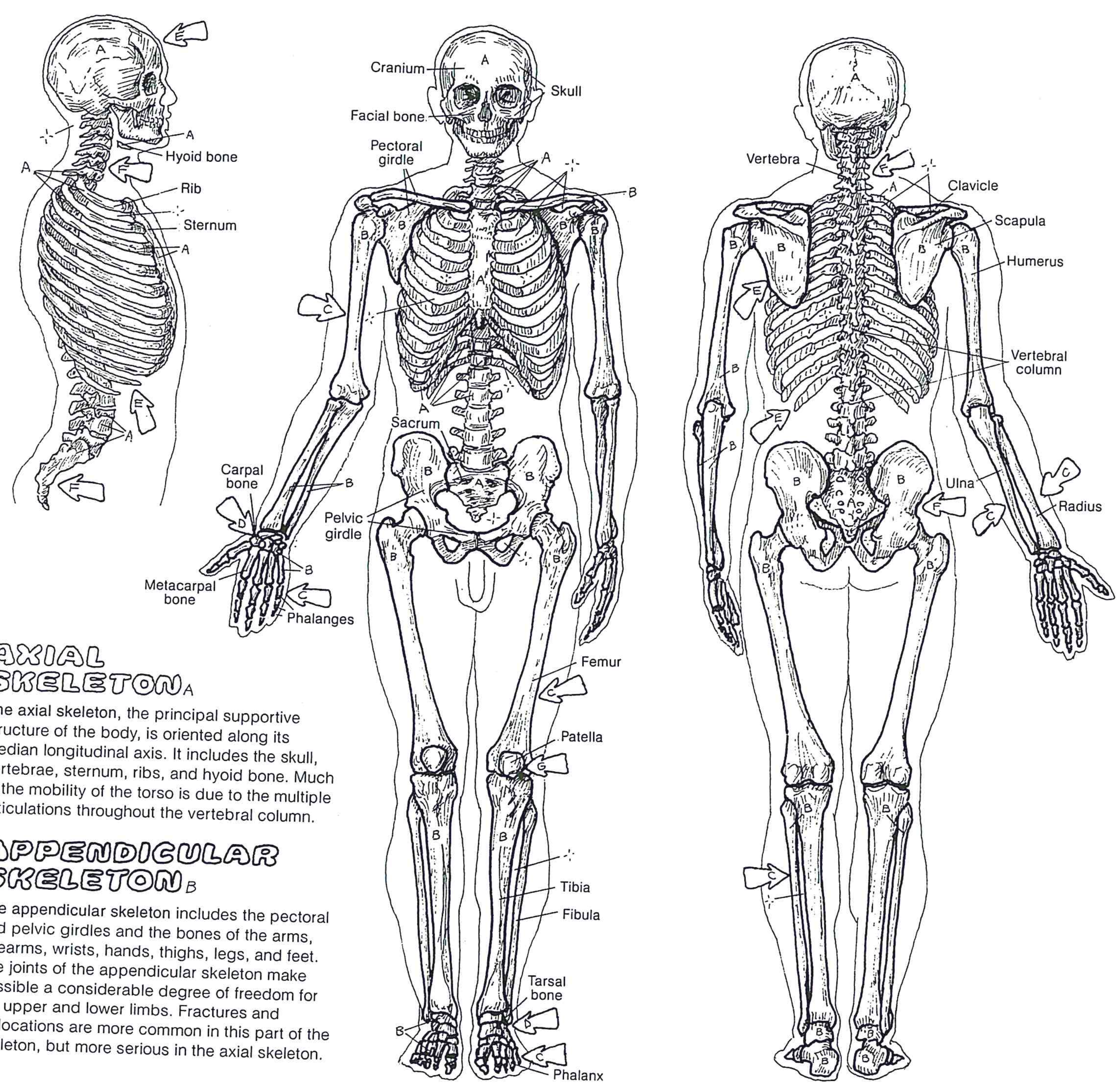


**CN:** Use light but contrasting colors for A and B.
(1) Color the axial skeleton (A) in all three views. Do not color the spaces between the ribs (intercostal).
(2) Color the darker, outlined appendicular skeleton (B).
(3) Color the arrows identifying bone shape/classification.

## CLASSIFICATION OF BONES

LONG C
SHORT D
FLAT E
IRREGULAR F
SESAMOID G

Bones have a variety of shapes and defy classification by shape; yet such a classification historically exists. *Long bones* are clearly longer in one axis than in another; they are characterized by a medullary cavity, a hollow diaphysis of compact bone, and at least two epiphyses—e.g., femur, phalanx. *Short bones* are roughly cube-shaped; they are predominantly cancellous bone with a thin cortex of compact bone and have no cavity—e.g., carpal and tarsal bones. *Flat bones* (cranial bones, scapulae, ribs) are generally more flat than round, and *irregular bones* (vertebrae) have two or more different shapes. Bones not specifically long or short fit this latter category. *Sesamoid bones* are developed in tendons (e.g., patellar tendon); they are mostly bone, often mixed with fibrous tissue and cartilage. They have a cartilaginous articular surface facing an articular surface of an adjacent bone; they may be part of a synovial joint ensheathed within the fibrous joint capsule. The structures are generally pea-sized and are most commonly found in certain tendons/joint capsules in hands and feet, and occasionally in other articular sites of the upper and lower limbs. The largest is the patella, integrated in the tendon of quadriceps femoris. Sesamoid bones resist friction and compression, enhance joint movement, and may assist local circulation.




## AXIAL SKELETON A

The axial skeleton, the principal supportive structure of the body, is oriented along its median longitudinal axis. It includes the skull, vertebrae, sternum, ribs, and hyoid bone. Much of the mobility of the torso is due to the multiple articulations throughout the vertebral column.

## APPENDICULAR SKELETON B

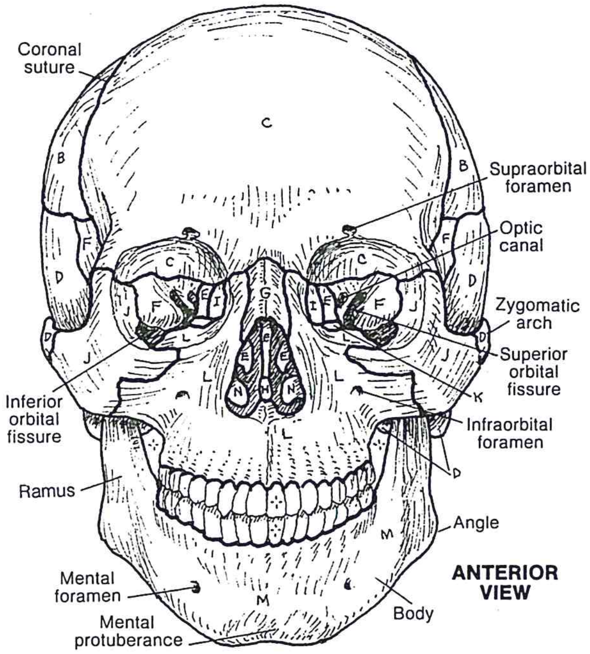
The appendicular skeleton includes the pectoral and pelvic girdles and the bones of the arms, forearms, wrists, hands, thighs, legs, and feet. The joints of the appendicular skeleton make possible a considerable degree of freedom for the upper and lower limbs. Fractures and dislocations are more common in this part of the skeleton, but more serious in the axial skeleton.

# BONES OF THE SKULL (1)

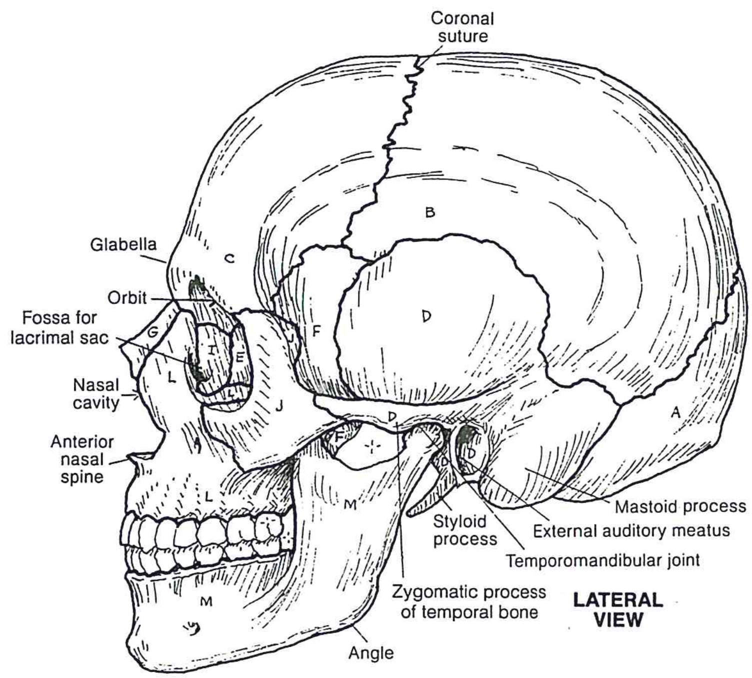
**8 CRANIAL** ✛
- OCCIPITAL A  2 PARIETAL B  FRONTAL C
- 2 TEMPORAL D  ETHMOID E  SPHENOID F

**14 FACIAL** ✛
- 2 NASAL G  VOMER H  2 LACRIMAL I
- 2 ZYGOMATIC J  2 PALATINE K  2 MAXILLA L
- MANDIBLE M  2 INFERIOR NASAL CONCHA N

**CN:** Save the brightest colors for the smallest bones and the lightest colors for the largest. (1) Color one bone in as many views as it appears before going on to the next. (2) There are some very small bones to color in the orbits and in the lower part of the posterior view of the skull. Study these areas carefully before coloring to determine the color boundaries. (3) Do not color the darkened areas in the orbits and nasal cavity in the anterior view.



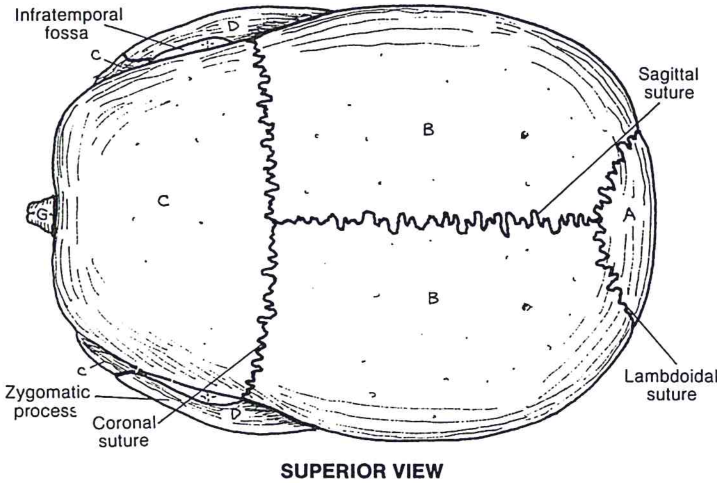

**ANTERIOR VIEW**



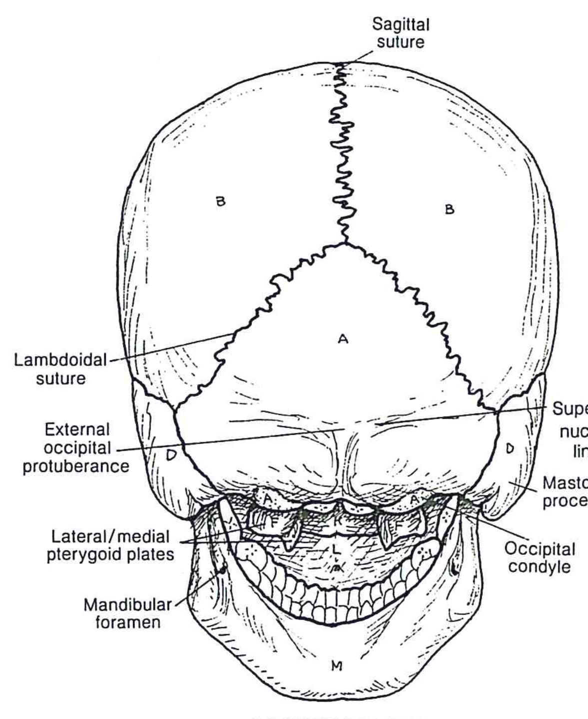

**LATERAL VIEW**

The skull is composed of *cranial bones* (forming a vault for the brain) and *facial bones* (giving origin to the muscles of facial expression and providing buttresses protecting the brain). Except for the temporomandibular joint (a synovial joint), all bones are connected by generally immovable fibrous sutures.

The orbit is composed of seven bones, has three significant fissures/canals, and is home to the eye and related muscles, nerves, and vessels. The most delicate of the skull bones is at the medial orbital wall. The external nose is largely cartilaginous and is therefore not part of the bony skull.




**SUPERIOR VIEW**




**POSTERIOR VIEW**

# VERTEBRAL COLUMN

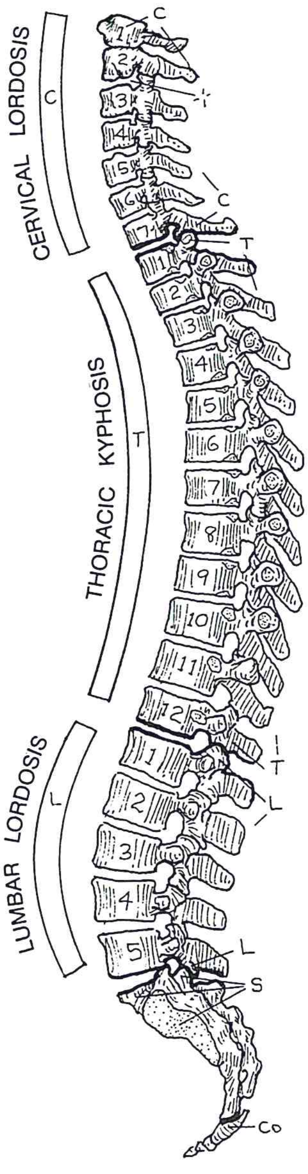
* color vertebral regions & disorders only
* colors are used on future plates (28, 29)



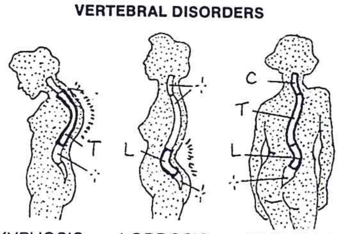
See 84

**CN:** ~~Use gray for D, yellow for H, and~~ light colors for the rest, especially C, T, L, S, and Co. L4 and L5 represent the lumbar vertebrae most involved in motion. (1) Begin with regions of the column and the three examples of vertebral disorders at lower left. (2) ~~Color the motion segment and its role in flexion and extension. (3) Color the vertebral foramina and canal. (4) Color the example of a protruding intervertebral disc pressing on a spinal nerve.~~

## REGIONS -:-
CERVICAL C
THORACIC T
LUMBAR L
SACRAL S
COCCYGEAL Co




VERTEBRAL DISORDERS




KYPHOSIS LORDOSIS SCOLIOSIS

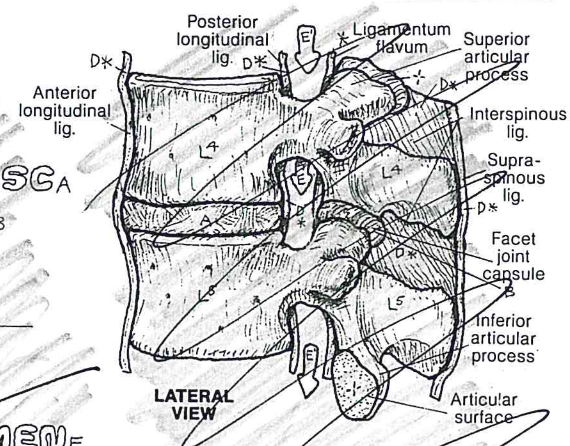
The vertebral column has 24 individual vertebrae arranged in *cervical*, *thoracic*, and *lumbar* regions; the *sacral* and *coccygeal* vertebrae are fused (sacrum/coccyx). Numbers of vertebrae in each region are remarkably constant; rarely S1 may be free or L5 may be fused to the sacrum (transitional vertebrae). The seven mobile cervical vertebrae support the neck and the 3–4 kg (6–8 lb) head. The cervical spine is normally curved (*cervical lordosis*) secondary to the development of postural reflexes about three months after birth. The 12 thoracic vertebrae support the thorax, head, and neck. They articulate with 12 ribs bilaterally. The thoracic spine is congenitally curved (*kyphosis*) as shown.

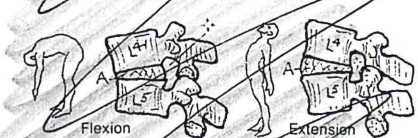
The five lumbar vertebrae support the upper body, torso, and low back. The column of these vertebrae becomes curved (*lumbar lordosis*) at the onset of walking at 1–2 years of age. The sacrum is the keystone of a weightbearing arch involving the hip bones. The sacral/coccygeal curve is congenital. The variably numbered 1–5 coccygeal vertebrae are usually fused, although the first vertebra may be movable.

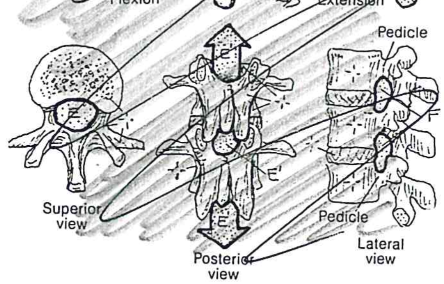
Vertebral curvatures may be affected (usually exaggerated) by posture, activity, obesity, pregnancy, trauma, and/or disease; these conditions are given the same names as the normal curves. A slight lateral curvature to the spine often reflects dominant handedness; a significant, possibly disabling, lateral curve (*scoliosis*) may occur for many reasons.

## MOTION SEGMENT -:-
VERTEBRA L4
JOINTS: -:-
INTERVERTEBRAL DISC A
POSTERIOR (FACET) B
LIGAMENT D*
VERTEBRA L5

VERTEBRAL FORAMEN E
VERTEBRAL CANAL E'
INTERVERTEBRAL FORAMEN F

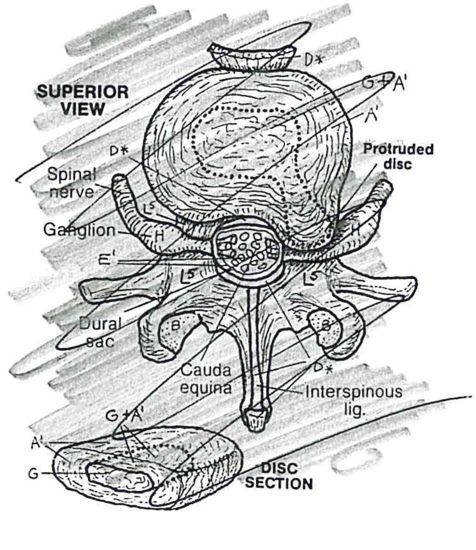



Each pair of individual, unfused vertebrae constitutes a *motion segment*, the basic movable unit of the back. Combined movements of motion segments underlie movement of the neck and the middle and low back. Each pair of vertebrae in a motion segment, except C1–C2, is attached by three joints: a partly movable, *intervertebral disc* anteriorly and a pair of gliding synovial *facet* (zygapophyseal) *joints* posteriorly. *Ligaments* secure the bones together and encapsulate the facet joints (joint capsules). The *vertebral* or *neural canal*, a series of *vertebral foramina*, transmits the spinal cord and related coverings, vessels, and nerve roots. Located bilaterally between each pair of vertebral pedicles are passageways, each called an *intervertebral foramen*, transmitting spinal nerves, their coverings/vessels, and some vessels to the spinal cord.

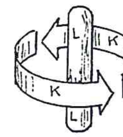
## INTERVERTEBRAL DISC A
ANNULUS FIBROSUS A'
NUCLEUS PULPOSUS G
SPINAL NERVE H

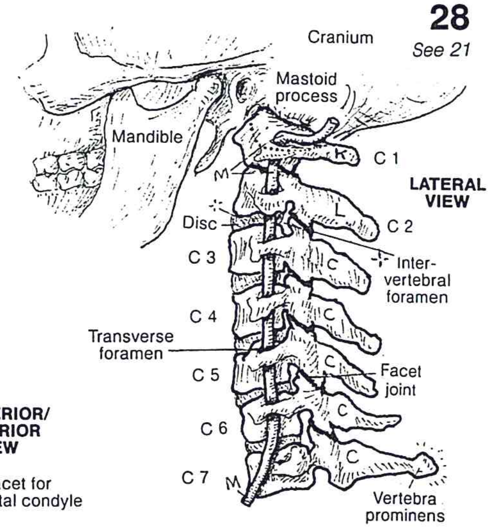



The intervertebral disc consists of the *annulus fibrosus* (concentric, interwoven collagenous fibers integrated with cartilage cells) attached to the vertebral bodies above and below, and the more central *nucleus pulposus* (a mass of degenerated collagen, proteoglycans, and water). The discs make possible movement between vertebral bodies. With aging, the discs dehydrate and thin, resulting in a loss of height. The cervical and lumbar discs, particularly, are subject to early degeneration from one or more of a number of causes. Weakening and/or tearing of the annulus can result in a broad-based bulge or a localized (focal) protrusion of the nucleus and adjacent annulus; such an event can compress a *spinal nerve* root as shown.

# CERVICAL & THORACIC VERTEBRAE

**CN:** Use red for M and use the same colors as were used on Plate ~~21~~ 27 for C and T. Use dark colors for N, O, and R. (1) Begin with the parts of a cervical vertebra. Color the atlas and axis and note they have been given separate colors to distinguish them from other cervical vertebrae. (2) Color the parts of a thoracic vertebra and then the thoracic portion of the vertebral column. Note the three different facet/demifacet colors.

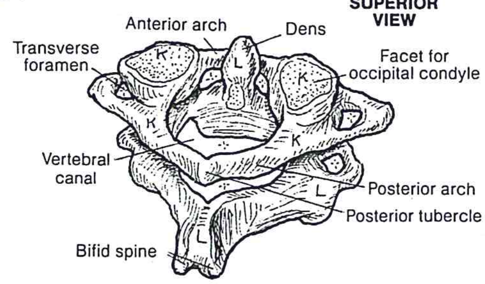


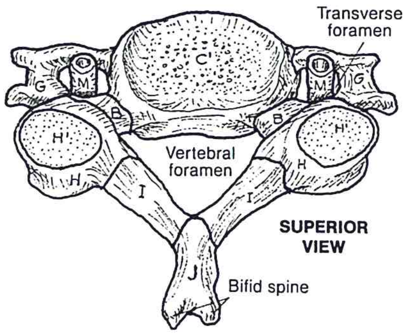




## CERVICAL VERTEBRA C
BODY C'
PEDICLE B
TRANSVERSE PROCESS G
ARTICULAR PROCESS H
FACET H'
LAMINA I
SPINOUS PROCESS J

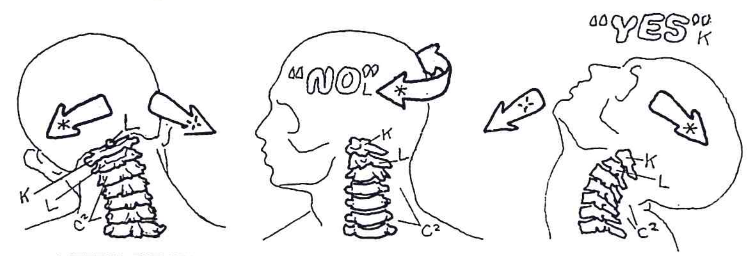
## ATLAS K
AXIS L

## VERTEBRAL ARTERY M



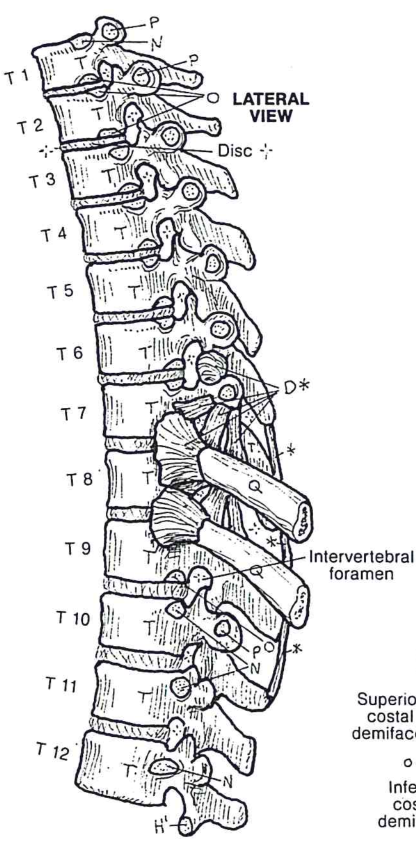



TYPICAL CERVICAL (C4) VERTEBRA



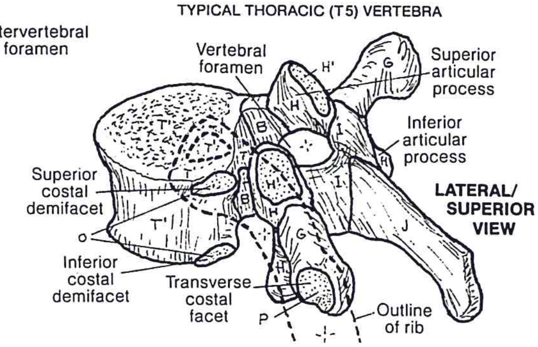
LATERAL FLEXION
ROTATION
FLEXION/EXTENSION

The small seven cervical vertebrae support and move the head and neck, supported by ligaments and strap-like paracervical (paraspinal) muscles. The ring-shaped *atlas* (C1) has no body; thus there are no weight-bearing discs between the occiput and C1, and between C1 and C2 (the *axis*). Head weight is transferred to C3 by the large *articular processes* and *facets* of C1 and C2. The atlantooccipital joints, in conjunction with the C3–C7 facet joints, permit a remarkable degree of flexion/extension ("yes" movements). The dens of C2 projects into the anterior part of the C1 ring, forming a pivot joint, enabling the head and C1 to rotate up to 80° ("no" movements). Such rotational capacity is permitted by the relatively horizontal orientation of the cervical facets. The C3–C6 vertebrae are similar; C7 is remarkable for its prominent *spinous process*, easily palpated. The anteriorly directed cervical curve and the extensive paracervical musculature preclude palpation of the other cervical spinous processes. The *vertebral arteries*, enroute to the brain stem, pass through foramina of the *transverse processes* of the upper six cervical vertebrae. These vessels are subject to stretching injuries with extreme cervical rotation of the hyperextended neck. The cervical vertebral canal conducts the cervical spinal cord and its coverings (not shown). The C4–C5 and C5–C6 motion segments are the most mobile of the cervical region and are particularly prone to disc/facet degeneration.




The twelve thoracic vertebrae—characterized by long, slender spinous processes, heart-shaped *bodies*, and nearly vertically oriented *facets*—articulate with *ribs* bilaterally. In general, each rib forms a synovial joint with two *demifacets* on the bodies of adjacent vertebrae and a single *facet* on the transverse process of the lower vertebra. Variations of these costovertebral joints are seen with T1, T11, and T12.

TYPICAL THORACIC (T5) VERTEBRA



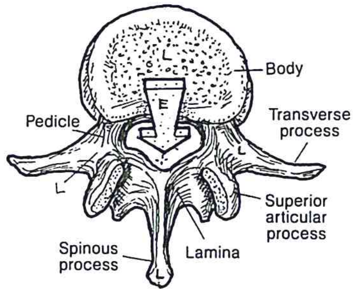

## THORACIC VERTEBRA T
BODY T'
FACET N
DEMIFACET O
TRANSVERSE FACET P
RIB Q
LIGAMENT D*

# LUMBAR, SACRAL & COCCYGEAL VERTEBRAE

**CN:** Use the same colors as were used on the previous two plates for C, T, L, E, F, A, S, and Co. (1) Begin with the three large views of lumbar vertebrae. (2) Color the different planes of articular facets. (3) Color the four views of the sacrum and coccyx. Note that the central portion of the median section receives the vertebral canal color (E[1]).

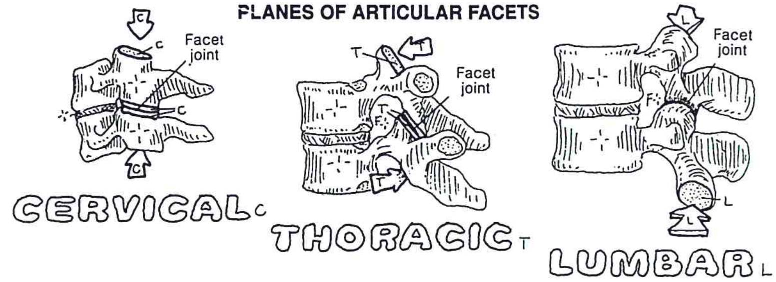
LUMBAR VERTEBRA L
VERTEBRAL FORAMEN E
VERTEBRAL CANAL E'
INTERVERTEBRAL FORAMEN F
INTERVERTEBRAL DISC A

The five lumbar vertebrae are the most massive of all the individual vertebrae, their thick processes securing the attachments of numerous ligaments and muscles/tendons. Significant flexion and extension of the lumbar and lumbosacral motion segments, particularly at L4–L5 and L5–S1, are possible. At about L1, the spinal cord terminates and the cauda equina (bundle of lumbar, sacral, and coccygeal nerve roots; see Plate 70) begins. The lumbar *intervertebral foramina* are large. Transiting nerve roots/sheaths take up only about 50% of the volume of these foramina. Disc and facet degeneration is common in the L4–L5 and L5–S1 segments; reduction of space for the nerve roots increases the risk of nerve root irritation/compression. Occasionally, the L5 vertebra is partially or completely fused to the sacrum (sacralized L5). The S1 vertebra may be partially or wholly non-fused (lumbarized S1), resulting in essentially six lumbar vertebrae and a sacrum of four fused vertebrae.

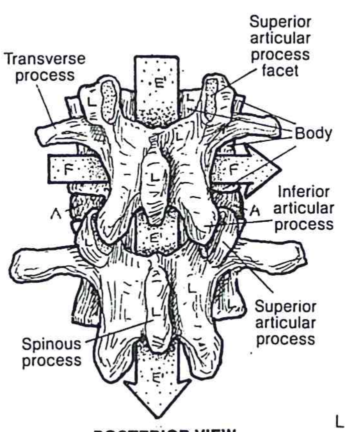


SUPERIOR VIEW

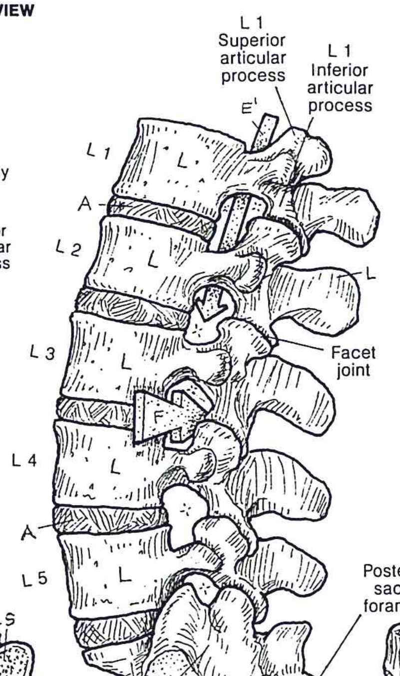
**PLANES OF ARTICULAR FACETS**

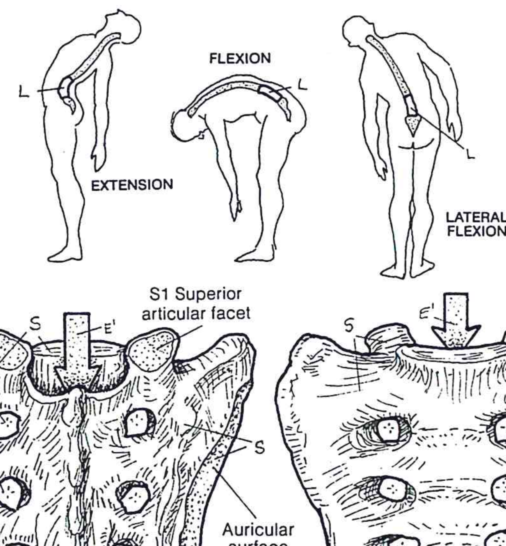



The planes (orientation) of the articular facets determine the direction and influence the degree of motion segment movement. The plane of the *cervical facets* is angled coronally off the horizontal plane about 30°. Considerable freedom of movement of the cervical spine is permitted in all planes (sagittal, coronal, horizontal). The *thoracic facets* lie more vertically in the coronal plane and are virtually non-weightbearing. The range of motion here is significantly limited in all planes, less so in rotation. The plane of the *lumbar facets* is largely sagittal, resisting rotation of the lumbar spine, transitioning to a more coronal orientation at L5–S1. The L4–L5 facet joints permit the greatest degree of lumbar motion in all planes.

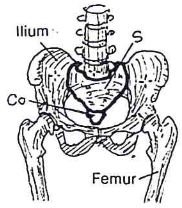


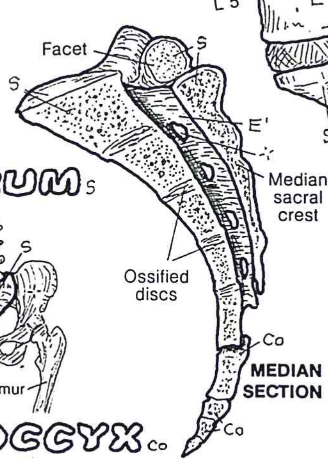
POSTERIOR VIEW



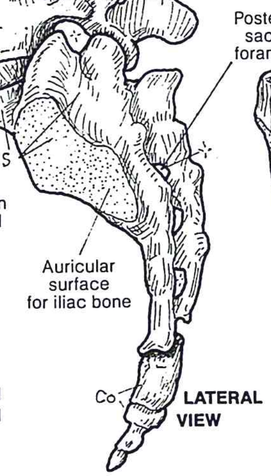




SACRUM S

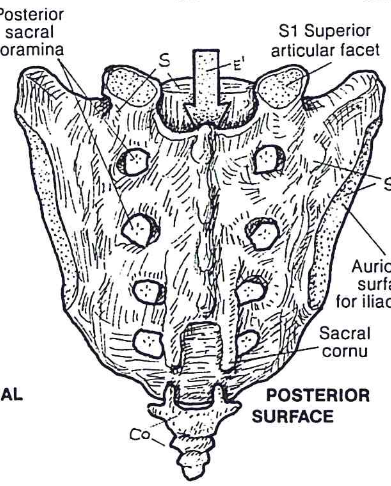


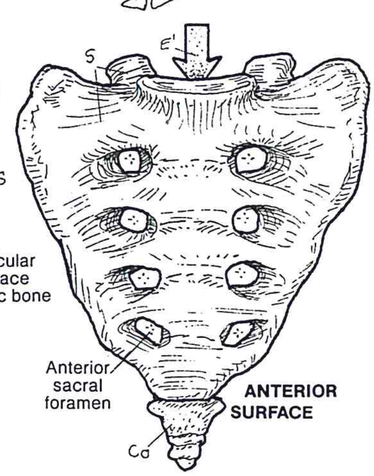
MEDIAN SECTION



LATERAL VIEW



POSTERIOR SURFACE



ANTERIOR SURFACE

COCCYX Co

The sacrum consists of five fused vertebrae; the intervertebral discs are largely replaced by bone. The sacral (vertebral) canal contains the terminal sac of the dura mater (dural sac, thecal sac) to S2 and the sacral nerve roots, which transit the sacral foramina. The sacrum joins with the ilium of the hip bone at the auricular surface, forming the sacroiliac joint.

The sacrum and the ilia of the hip bones form an arch for the transmission and distribution of weightbearing forces to the heads of the femora. It is a strong arch, and the sacrum is its keystone. The coccyx consists of 2–4 tiny individual or partly fused, rudimentary vertebrae. The first coccygeal vertebra is the most completely developed.