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Bones and Muscles

Protective design of the skeleton • Macroscopic and microscopic structure of the bones • Bone growth and development
Joints • Three kinds of muscles
Structure of skeletal muscles • Muscles and exercise

The framework of the human body is its **skeletal system**, composed of approximately 206 bones that support the body and protect vital organs. The body's bones are masterpieces of structural design, comparable in strength to reinforced concrete, yet self-repairing and far more resilient. Precisely engineered joints between bones allow the body to move; the power for movement is provided by strong muscles attached to the bones by cablelike tendons. In addition to their structural roles, bones

also serve to produce blood cells. This vital function is carried out by bone marrow inside the body's long bones, which manufactures new red blood cells at the astonishing rate of more than 2 million per second. The marrow also produces white blood cells, the agents of the body's immune system. Finally, bones serve as a reservoir of important minerals such as calcium and phosphorus. Bones account for about 20 percent of the body's weight.

According to God's precise engineering, the **muscular system** functions together with the skeletal system and the nervous system to make body movements possible. The individual organs of the muscular system are the skeletal muscles, which make up about between 40 and 50 percent of the body's weight.

Fig. 7.1 Axial skeleton



7.1 The Axial Skeleton

The skeletal system consists of two broad divisions, the *axial skeleton* and the *appendicular skeleton*. The **axial** [äk'sē·əl] **skeleton** is literally the “backbone” of the skeletal system; it is made up of eighty bones that constitute the head and spine. Its members include the *bones of the skull*, the *hyoid* [hī'oid'] *bone* in the neck, the *vertebrae* [vūr'tə·brā'] of the neck and backbone, the *sternum* or breastbone, and the *ribs*. The *appendicular skeleton*, on the other hand, refers to the bones of the appendages (arms and legs), shoulders, and hips.

Bones of the Head

Cranial bones. Your *skull* can be divided into two main parts, the *cranium* and the *facial bones*. The largest portion of the skull is the **cranium**, or *brain case*, which composes the top, sides, and rear of the

skull. The cranium is made up of eight bones joined tightly together to form an armored shell for the brain. Important cranial bones include the *frontal bone* (forehead), the *parietal* [pə·ri'ī·təl] bones (top of the head), the *temporal bones* (sides of the head), and the *occipital* [ök·sip'ī·tl] bone (back of the head).

Although these bones are fused tightly together in an adult, they are joined only loosely together in the skull of an infant. The bones of an infant's cranium are connected by tough membranes, known as **fontanels** [fɒn'tənəlz'], made of fibrous connective tissue; the fontanels are responsible for the "soft spots" on the top and back of an infant's head. The flexibility imparted by the fontanels allows the baby's skull to deform somewhat in order to fit through the narrow birth canal during the miracle of birth. The fontanels also enable the skull to grow larger as the child grows. The gaps between the infant's cranial bones gradually shrink as the fontanels are replaced by growing bone. Within a year or two, the fontanels disappear completely, and the cranial bones are joined tightly together at uneven lines known as **sutures** [sū'chərz]. The jagged sutures are another evidence of God's design; they give the skull great strength by helping to absorb some of the shock from a blow to the head.

Facial bones. The 14 bones of the **facial skeleton** serve as the framework of the face and jaw. The most important of the facial bones are the two *maxillary* [māk'sə·lēr'ē] bones, which form the central portion of the face and serve as the attachments for your upper teeth. The maxillary bones, together with the *palatine* [pāl'ə·tīn'] bones located behind them, also form the roof of the mouth, or *palate* [pāl'īt]. The *mandible* [mān'də·bəl], which forms the lower jaw and holds the lower teeth, is **the only movable bone of the skull** and is held to the cranium by strong connective tissues known as **ligaments** [līg'ə·mənts: tissues that join bones to other bones].

Sinuses. Certain bones of the skull are designed with hollow spaces known as **sinuses**

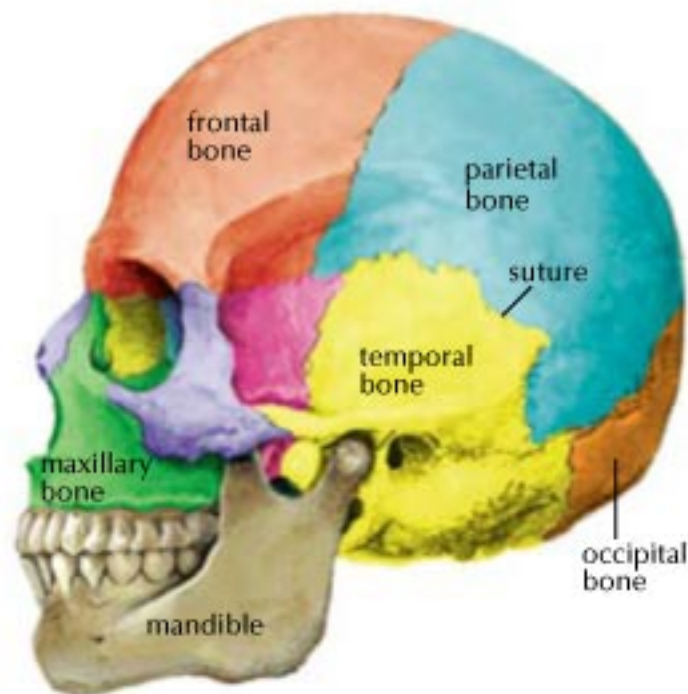


Fig. 7.2 Cranium and facial skeleton

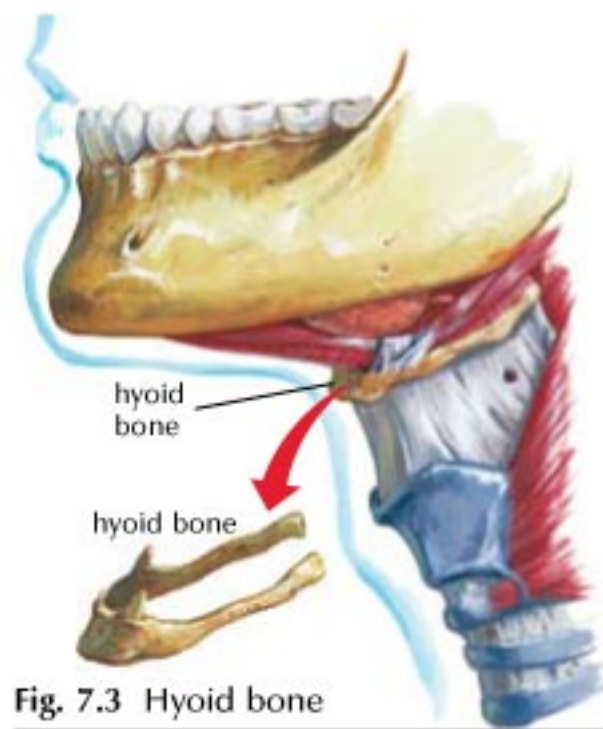


Fig. 7.3 Hyoid bone

[si'nəs·əz]. Large sinuses are located in the maxillary bones of the face and in the frontal and sphenoid bones of the cranium. When you speak, sound waves resonate within the sinuses, helping to give your voice its characteristic vocal quality. In addition, your hollow sinuses allow your skull to be lighter than if it were made of solid bone.

The hyoid and middle ear bones. An important bone hidden in the upper neck, just above your larynx (voicebox), is the U-shaped **hyoid bone**. Although not considered part of the skull, the hyoid bone serves as the foundation of many of the tongue muscles and of certain other muscles that allow you to swallow.

The **smallest bones in the human body** are the three middle ear bones, the *malleus* [mäl'ē·əs: hammer], *incus* [īng'kəs: anvil] and *stapes* [stā'pēz: stirrup]. These structures, located in a hollow cavity inside each temporal bone, constitute a mechanical linkage between the eardrum and the cochlea (the snail-shaped structure of the inner ear that senses sound vibrations). This linkage serves to amplify the vibrations of the eardrum and pass them to the cochlea, enabling you to hear.

Bones of the Spine

The chief structural member of the body is the **vertebral column** (also known as the *spine*, *spinal column*, or *backbone*), a massive columnlike structure which, in an adult, consists of 33 segments called **vertebrae** [sing. *vertebra*]. The vertebral column serves as the support to which all the other parts of the skeleton are attached. Between the vertebrae are disks of flexible cartilage called **intervertebral**

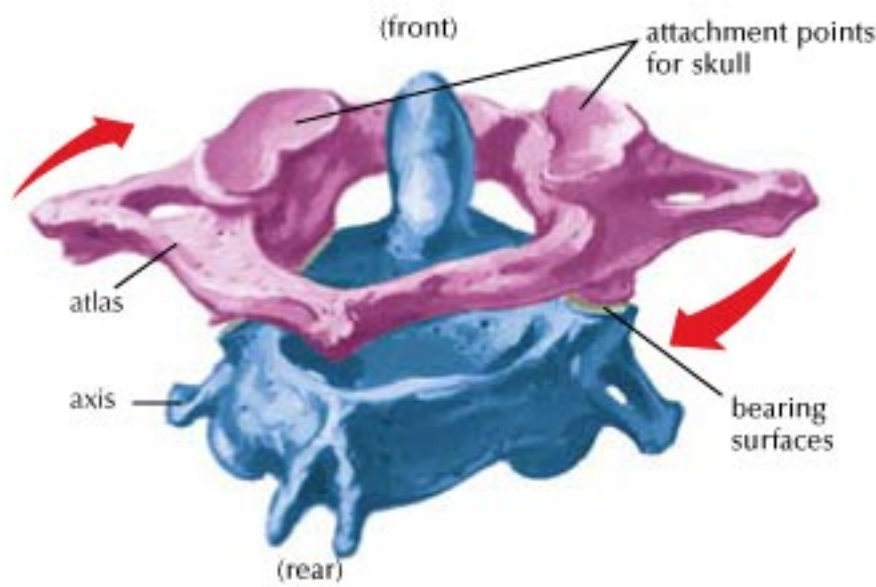


Fig. 7.4 Atlas and axis

[ɪn'tər·vûr'tə·brəl] **disks**, which allow the spine to bend and twist somewhat; these disks also act as shock absorbers. (**Cartilage** is a tough, rubbery connective tissue that cushions the joints between bones.) Hollow cavities near the rear of each vertebra form a long vertical tunnel through the spine that encloses the spinal cord, protecting it from damage.

Regions of the vertebral column. The vertebral column is divided into four regions: *cervical* [sûr'vî·kəl: the neck], *thoracic* [thə·rās'îk: the chest], *lumbar* [lûm'bər: the lower back], and *pelvic* [pəl'vîk: the pelvis] or *sacral* [sā'krəl: the sacrum].

The seven vertebrae that form the neck are called the **cervical vertebrae**. The uppermost of these, known as the *atlas*, serves as the mounting to which the head is connected. Special bearings on the atlas allow the head to rotate upward or downward while keeping your neck straight. The second cervical vertebra, the *axis*, is designed as the base for the atlas. Bearing surfaces on the axis allow the atlas to swivel left or right. The other five cervical vertebrae are joined together by intervertebral disks; the flexibility of these disks allows the head to tilt to the side and crane backward or forward.

The longest segment of the vertebral column is composed of the twelve **thoracic vertebrae**. Slightly larger and thicker than the cervical vertebrae, the thoracic vertebrae serve as attachments for the rib cage. Below the thoracic vertebrae, the spine widens into the five **lumbar vertebrae**, which are the largest of all the vertebrae. The lumbar vertebrae form the lower back and support the weight of the entire upper body. When the lumbar vertebrae are engaged with the supporting

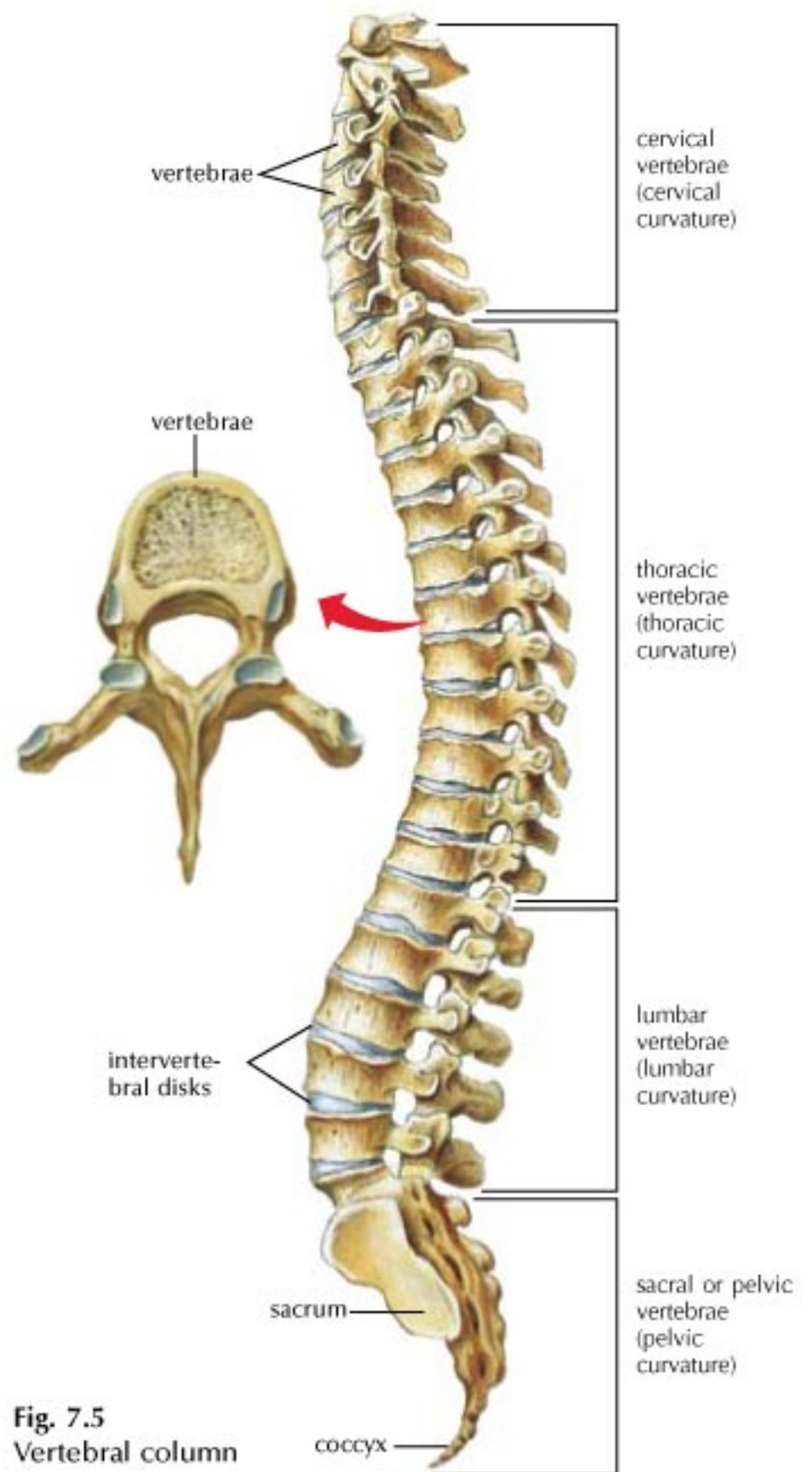


Fig. 7.5 Vertebral column

muscles, they can bear very heavy burdens—another striking example of God's design and provision. The pelvic region consists of the **sacral vertebrae**, which are five separate vertebrae in infants but are fused into a single bone, called the *sacrum*, in adults. The sacrum is joined rigidly to the hip bones to form the foundation of the spine. Beneath the sacrum is the tiny **coccyx**, which consists of four separate vertebrae in infants but are fused into a single bone in adults. Also known as the *tailbone*, the coccyx serves as an attachment for various muscles that allow us to stand in an upright position and aid in the elimination of wastes. The coccyx also helps to absorb the shock to your spine when you sit down.

Curvatures of the vertebral column. The vertebrae do not form a straight, pillarlike column, but instead form four curvatures from front to back: the cervical curvature, the thoracic curvature, the lumbar curvature, and the pelvic curvature (Fig. 7.5). God designed these curves of the vertebral column to provide the spine with additional strength and flexibility, allowing it to absorb shocks and helping to protect it against fracture.

The spine also has a slight sideways curve in most people (this is normal). However, in some people, the spine has an excessive lateral (sideways) curve, causing one shoulder blade to protrude abnormally and one side of the waist or hips to be higher than the other. A severe lateral curvature of the spine is known as **scoliosis** [skō'lē·ō'sis].

Bones of the Chest

The vital internal organs of the thoracic cavity, such as the heart and lungs, are protected by the bones of the chest, which make up the **thoracic cage**. The most prominent bones of the thoracic cage are the **ribs**, long, curved bones that are attached to the thoracic vertebrae in back and to the **sternum**, or breastbone, in the front. Although the ribs attach directly to the thoracic

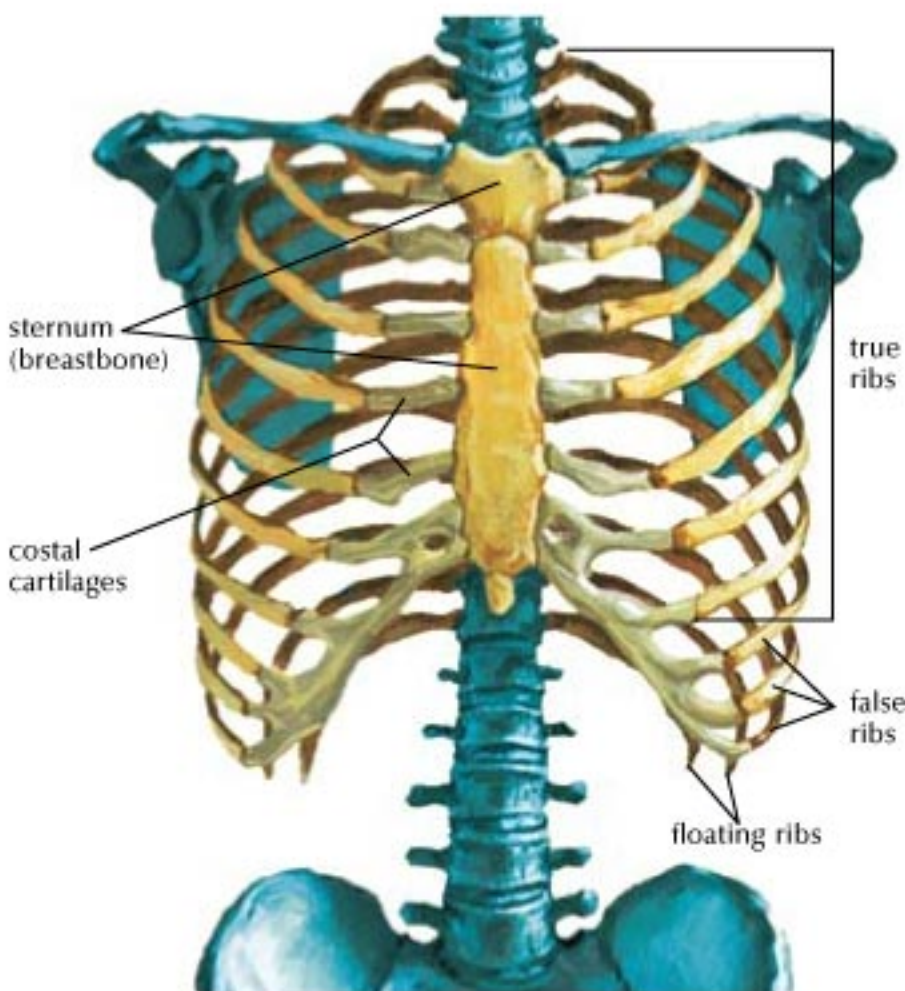


Fig. 7.6 Thoracic cage

vertebrae, they are joined to the sternum indirectly by short segments of flexible cartilage called the *costal* [kōs'təl] *cartilages* (the Latin word *costa* means “rib”). Because the costal cartilages are not rigid bone but rather flexible cartilage, they allow the thoracic cage to expand and contract during breathing. Only the upper seven pairs of ribs are attached (via their costal cartilages) to the sternum itself; for this reason, the upper seven pairs of ribs are called *true ribs*. The rest of the ribs, which do not connect to the sternum itself, are known as *false ribs*. The bottom two pairs of false ribs are called *floating ribs* because they do not connect to the front of the thoracic cage at all; the remaining three pairs of false ribs are attached to the costal cartilages of the lowest pair of true ribs instead of to the sternum.

Section Review 7.1

1. What are the two broad divisions of the skeleton?
2. Name the major bones of the head and chest.
3. Describe the functions of the cranium, fontanel, sutures, and sinuses.
4. Describe the functions of the hyoid bone and the middle ear bones.
5. Name the bones, regions, and curves of the vertebral column.
6. What characteristics distinguish true ribs from false ribs and floating ribs?

Application:

7. In a paragraph, explain how the structure of the skull is an example of God's design and provision for man.

Critical Thinking:

8. Men and women both have exactly 12 pairs of ribs. Why is this not a contradiction of Genesis 2:21–22?

Identify:

cranium, ligament, cartilage, cervical, thoracic, lumbar, scoliosis

7.2

The Appendicular Skeleton

The skeletal system consists of two broad divisions, the *axial skeleton* and the *appendicular skeleton*. The **appendicular** [äp'ən·dīk'yə·lər] **skeleton** includes the 126 bones that form the *pectoral girdle* (the shoulders), the *pelvic girdle* (the hips), and the *appendages* (the arms and legs).