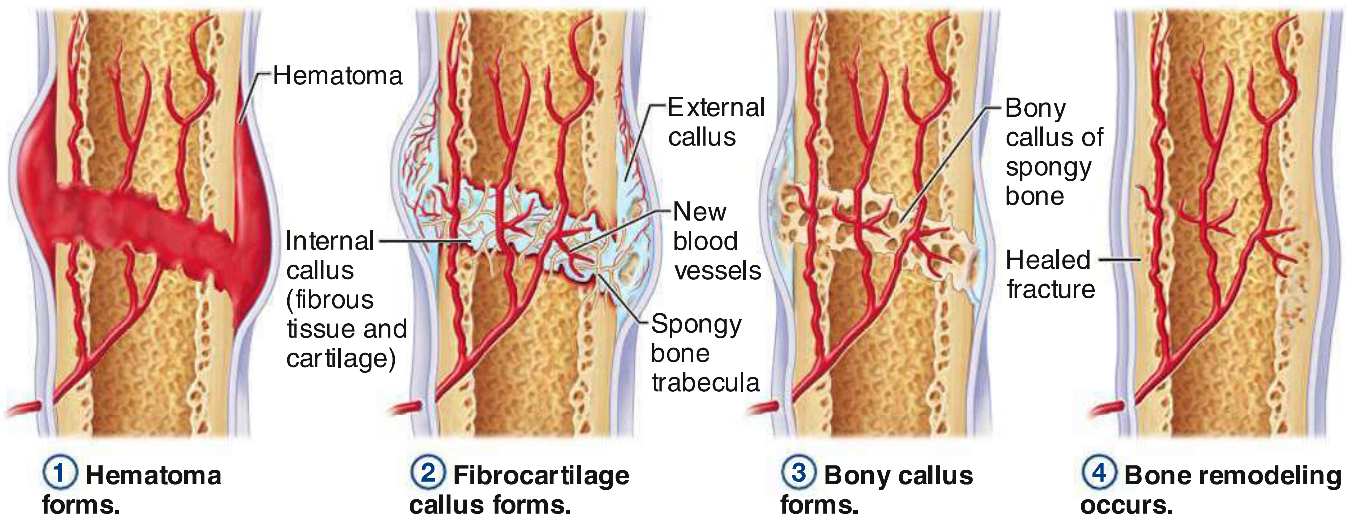


Figure 5.7 Stages in the healing of a bone fracture.

Bone Fractures

✓ Name and describe the various types of fractures.

HOMEOSTATIC IMBALANCE

For their relatively low mass, bones are amazingly strong. Consider, for example, the forces endured in touch football and professional hockey. Despite their remarkable strength, bones are susceptible to **fractures,** or breaks, all through life. During youth, most fractures result from exceptional trauma that twists or smashes the bones. Sports activities such as football, skating, and skiing jeopardize the bones, and automobile accidents certainly take their toll. In old age, bones thin and weaken, and fractures occur more often.

A fracture in which the bone breaks cleanly but does not penetrate the skin is a *closed* (or *simple*) *fracture*. When the broken bone ends penetrate through the skin, the fracture is *open* (or *compound*). Some of the many common types of fractures are illustrated and described in **Table 5.2**.

A fracture is treated by **reduction,** which is the realignment of the broken bone ends. In *closed reduction,* the bone ends are coaxed back into their normal position by the physician's hands. In *open reductions,* surgery is performed and the bone ends are secured together with pins or wires. After the broken bone is reduced, it is immobilized by a cast or traction to allow the healing process to begin. The healing time for a simple fracture is 6 to 8 weeks, but it is much longer for large bones and for the bones of older people (because of their poorer circulation).

The repair of bone fractures involves four major events (**Figure 5.7**):

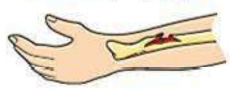
1. **A hematoma forms.** Blood vessels are ruptured when the bone breaks. As a result, a blood-filled swelling called a **hematoma** (he-mah-to′mah) forms. Bone cells deprived of nutrition die.

2. **A fibrocartilage callus forms.** As described in Chapter 3, an early event of tissue repair (and bone repair is no exception) is the growth of new capillaries (granulation tissue) into the clotted blood at the site of the damage and disposal of dead tissue by phagocytes. As this goes on, connective tissue cells of various types form a mass of repair tissue, the **fibrocartilage callus** (kal′us), that contains several elements—some cartilage matrix, some bony matrix, and collagen fibers—and acts to "splint" the broken bone, closing the gap.

3. **The bony callus forms.** As more osteoblasts and osteoclasts migrate into the area and multiply, the fibrocartilage callus is gradually replaced by the **bony callus** made of spongy bone.

4. **Bone remodeling occurs.** Over the next few weeks to months, depending on the bone's

Table 5.2 Common Types of Fractures

Fracture type	Illustration	Description	Comment
Comminuted		Bone breaks into many fragments	Particularly common in older people, whose bones are more brittle
Compression		Bone is crushed	Common in porous bones (i.e., osteoporotic bones of older people)
Depressed		Broken bone portion is pressed inward	Typical of skull fracture
Impacted		Broken bone ends are forced into each other	Commonly occurs when someone attempts to break a fall with outstretched arms
Spiral		Ragged break occurs when excessive twisting forces are applied to a bone	Common sports fracture
Greenstick		Bone breaks incompletely, much in the way a green twig breaks	Common in children, whose bones are more flexible than those of adults

size and site of the break, the bony callus is remodeled in response to the mechanical stresses placed on it, so that it forms a strong, permanent "patch" at the fracture site.

DID YOU GET IT?

10. What is a fracture? What two fracture types are particularly common in older people?

For answers, see Appendix D.

Axial Skeleton

As noted earlier, the skeleton is divided into two parts, the *axial* and *appendicular skeletons.* The axial skeleton, which forms the longitudinal axis of the body, is shown as the green portion of **Figure 5.8**. It can be divided into three parts—the *skull,* the *vertebral column,* and the *thoracic cage.*

Skull

✓ On a skull or diagram, identify and name the bones of the skull.

✓ Describe how the skull of a newborn infant (or fetus) differs from that of an adult, and explain the function of fontanels.

The **skull** is formed by two sets of bones. The **cranium** encloses and protects the fragile brain tissue. The **facial bones** hold the eyes in an anterior position and allow the facial muscles to show our feelings through smiles or frowns. All but one of the bones of the skull are joined together by *sutures,* which are interlocking, immovable joints. Only the mandible (jawbone) is attached to the rest of the skull by a freely movable joint.

Cranium

The boxlike cranium is composed of eight large flat bones. Except for two paired bones (the parietal and temporal), they are all single bones.

Frontal Bone The frontal bone forms the forehead, the bony projections under the eyebrows, and the superior part of each eye's orbit (**Figure 5.9**).

Parietal Bones The paired parietal bones form most of the superior and lateral walls of the cranium (see Figure 5.9). They meet in the midline of

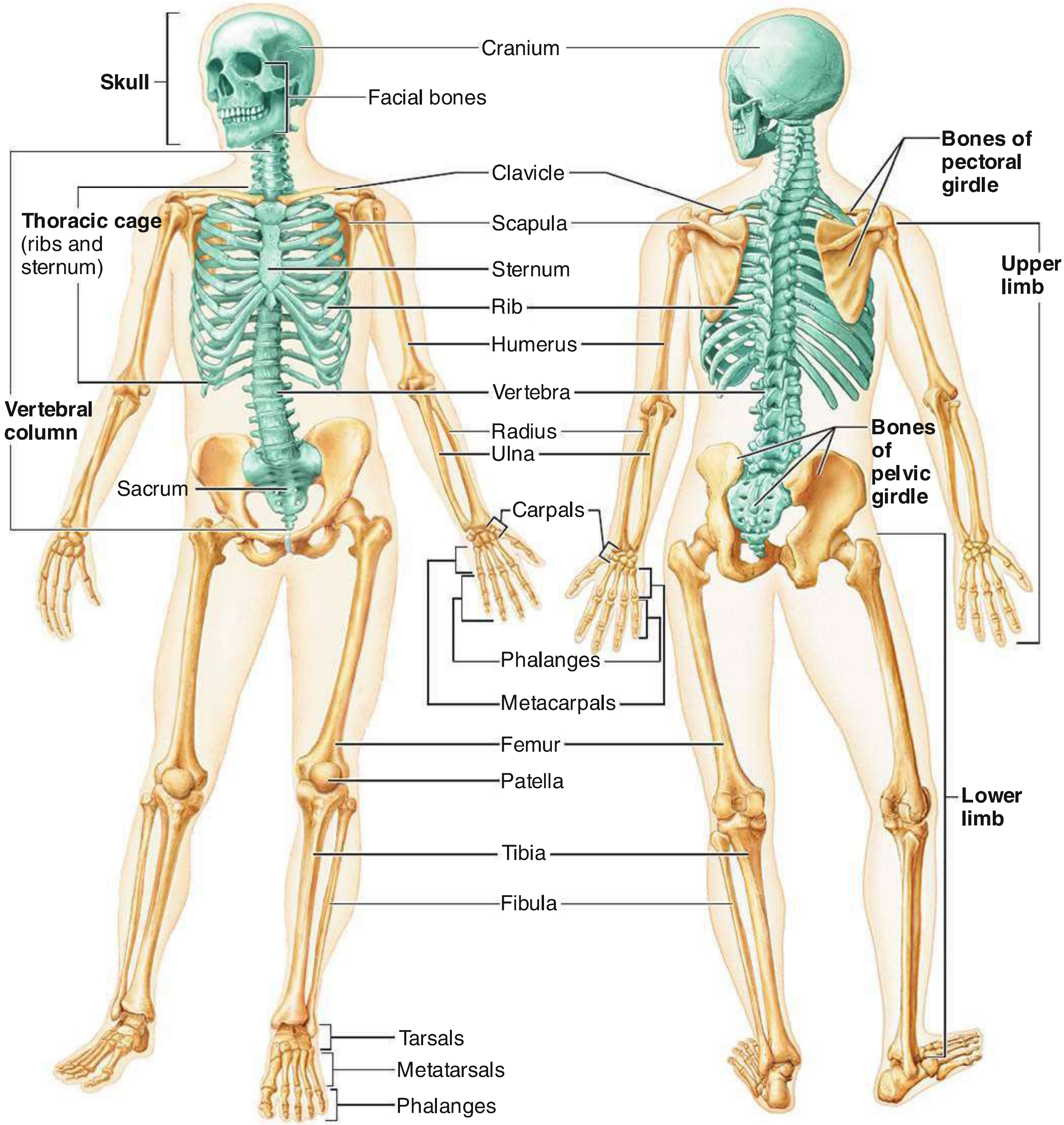


Figure 5.8 **The human skeleton.** The bones of the axial skeleton are colored green. Bones of the appendicular skeleton are gold.

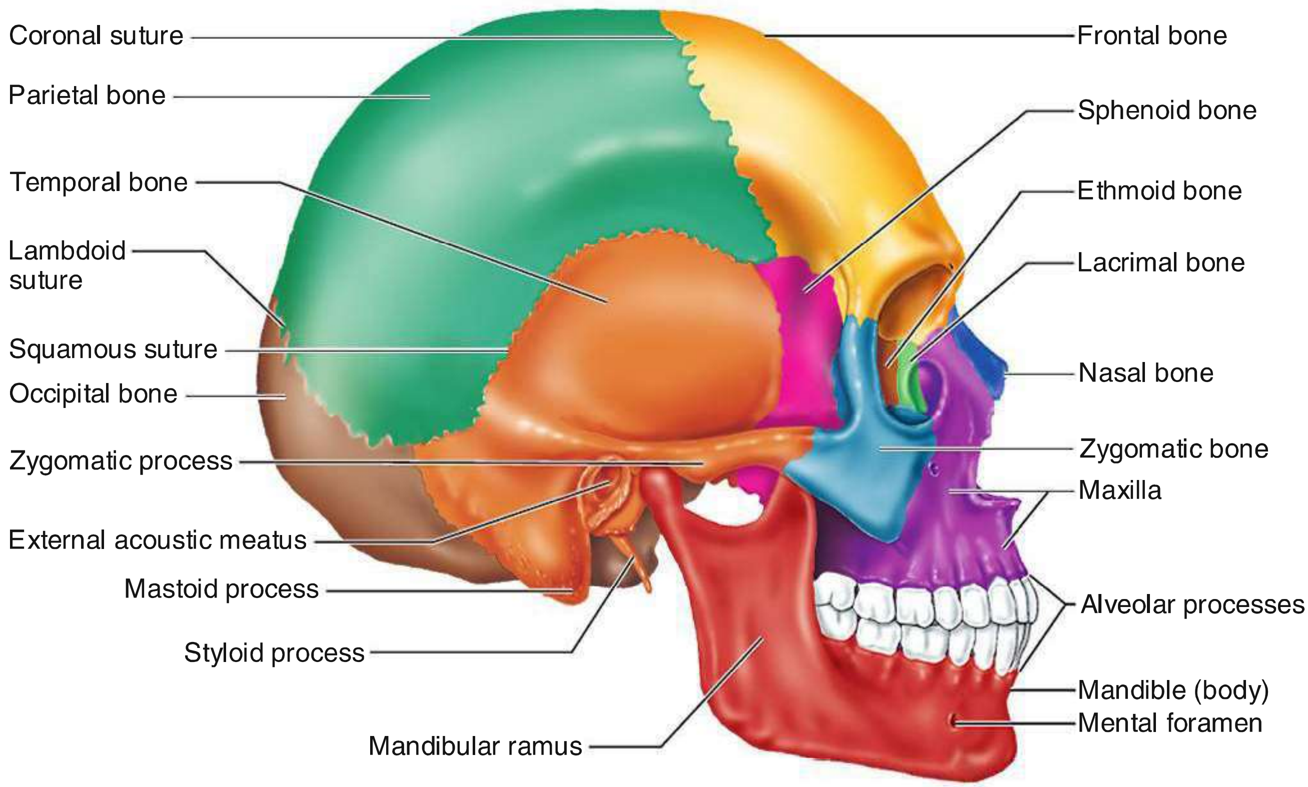


Figure 5.9 Human skull, lateral view.

the skull at the **sagittal suture** and form the **coronal suture,** where they meet the frontal bone.

Temporal Bones The temporal bones lie inferior to the parietal bones; they join them at the **squamous sutures.** Several important bone markings appear on the temporal bone (see Figure 5.9):

- The **external acoustic meatus** is a canal that leads to the eardrum and the middle ear. It is the route by which sound enters the ear.
- The **styloid process,** a sharp, needlelike projection, is just inferior to the external auditory meatus. Many neck muscles use the styloid process as an attachment point.
- The **zygomatic** (zi″go-mat′ik) **process** is a thin bridge of bone that joins with the cheekbone (zygomatic bone) anteriorly.
- The **mastoid** (mas′toid) **process,** which is full of air cavities (mastoid sinuses), is a rough projection posterior and inferior to the external acoustic meatus. It provides an attachment site for some muscles of the neck.

  The mastoid sinuses are so close to the middle ear—a high-risk spot for infections—that they may become infected too, a condition called *mastoiditis*. Also, this area is so close to the brain that mastoiditis may spread to the brain.
- The **jugular foramen,** at the junction of the occipital and temporal bones (**Figures 5.10** and **5.11**), allows passage of the jugular vein, the largest vein of the head, which drains the brain. Just anterior to it in the cranial cavity is the **internal acoustic meatus** (see Figure 5.10), which transmits cranial nerves VII and VIII (the facial and vestibulocochlear nerves). Anterior to the jugular foramen on the skull's inferior aspect is the **carotid canal** (see Figure 5.11), through which the internal carotid artery runs, supplying blood to most of the brain.

Occipital Bone If you look at Figures 5.9, 5.10, and 5.11, you can see that the occipital (ok-sip′ĭ-tal) bone is the most posterior bone of the cranium. It forms the base and back wall of the skull. The occipital bone joins the parietal bones anteriorly at the **lambdoid** (lam′doyd) **suture.** In the base of the occipital bone is a large opening, the **foramen magnum** (literally, "large hole"). The foramen magnum surrounds the lower part of the brain and allows the spinal cord to connect with

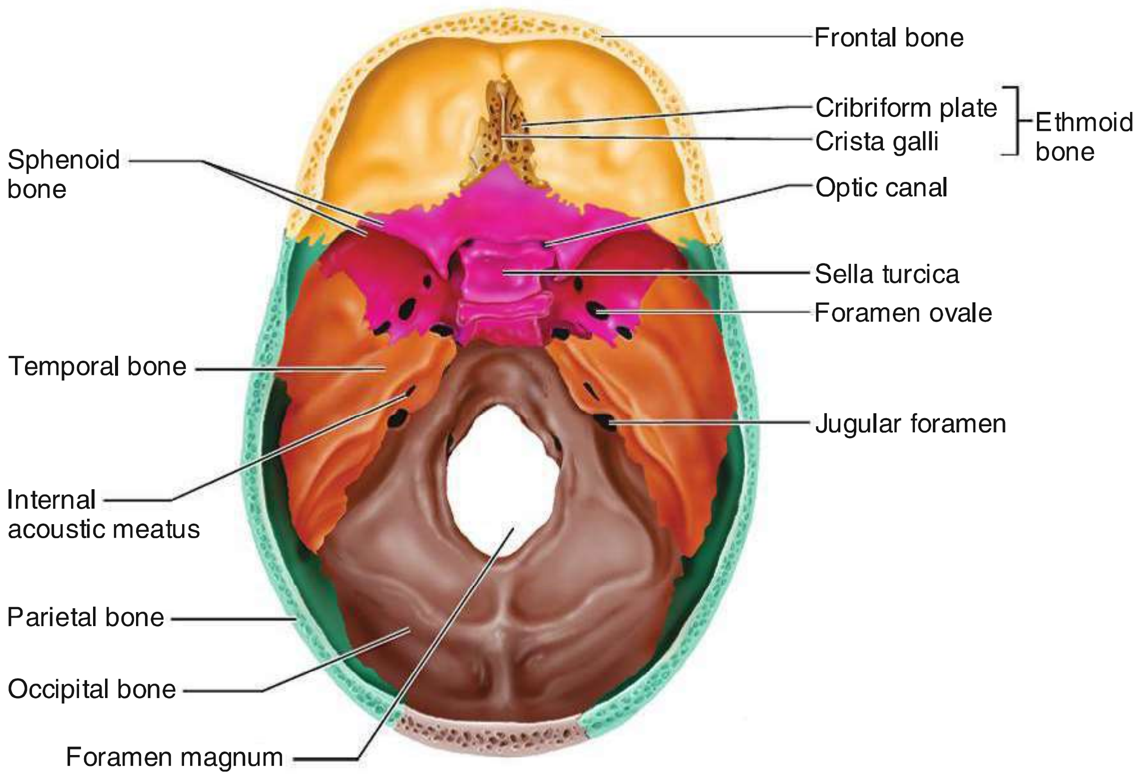


Figure 5.10 **Human skull, superior view (top of cranium removed).**

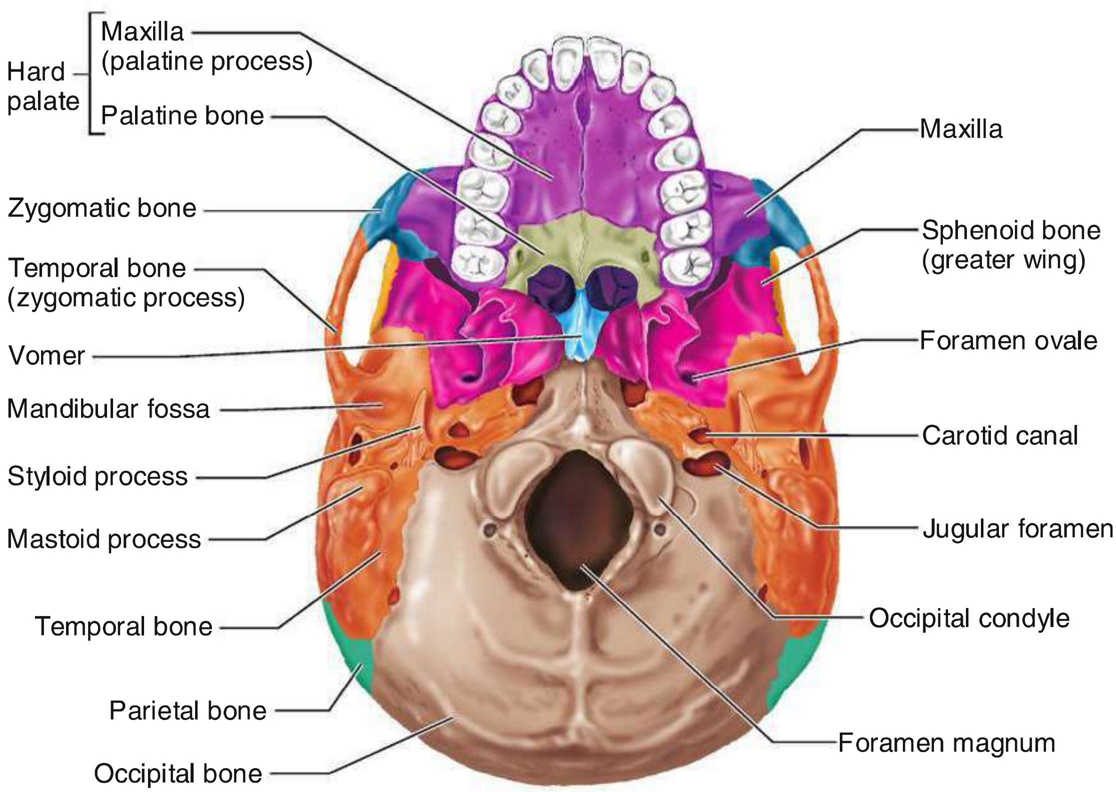


Figure 5.11 **Human skull, inferior view (mandible removed).**

Q: *What bone articulates with every other facial bone?*

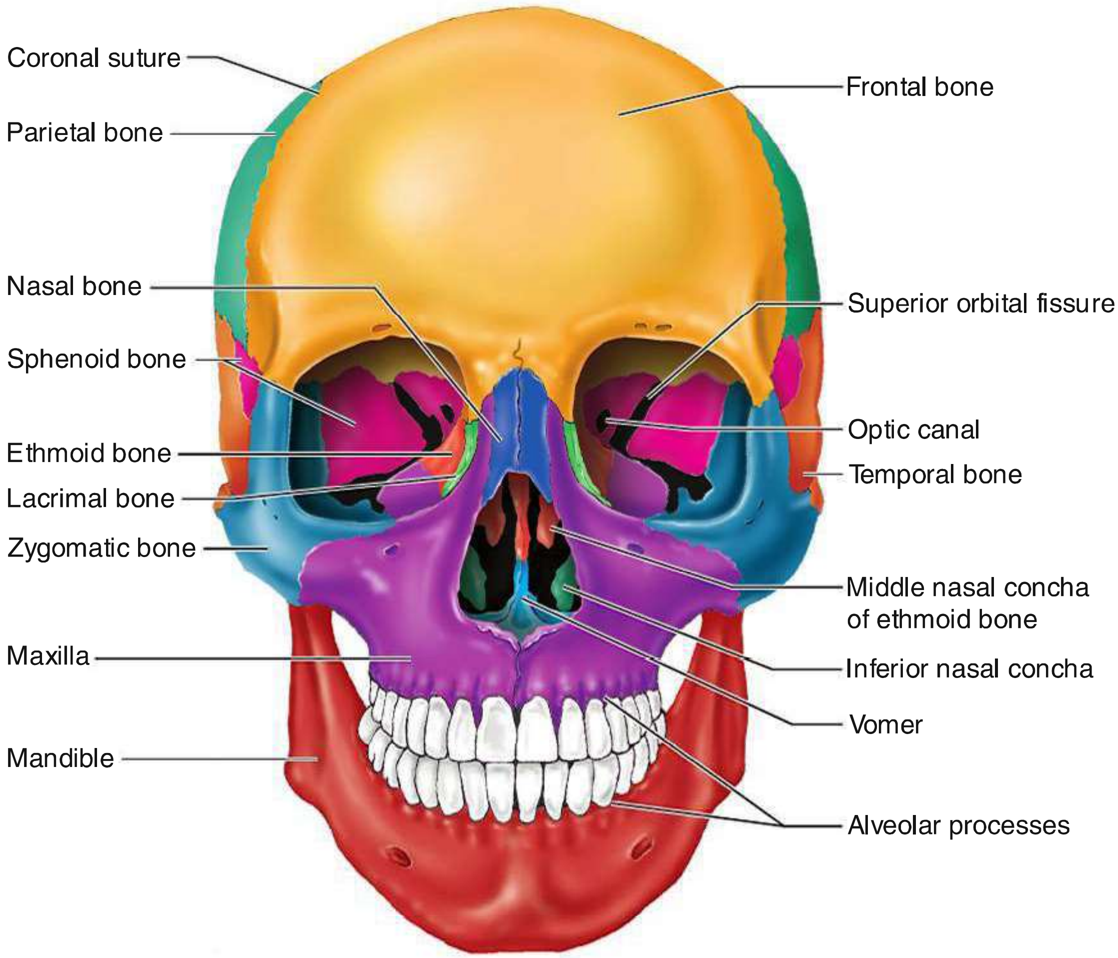


Figure 5.12 **Human skull, anterior view.**

the brain. Lateral to the foramen magnum on each side are the rockerlike **occipital condyles** (see Figure 5.11), which rest on the first vertebra of the spinal column.

Sphenoid Bone The butterfly-shaped sphenoid (sfe′noid) bone spans the width of the skull and forms part of the floor of the cranial cavity (see Figure 5.10). In the midline of the sphenoid is a small depression, the **sella turcica** (sel′ah tur′sĭ-kah), or *Turk's saddle,* which forms a snug enclosure for the pituitary gland. The **foramen ovale,** a large oval opening in line with the posterior end of the sella turcica (Figure 5.10), allows fibers of cranial nerve V (the trigeminal nerve) to pass to the chewing muscles of the lower jaw (mandible). Parts of the sphenoid bone, seen exteriorly forming part of the eye orbits, have two important openings, the **optic canal,** which allows the optic nerve to pass to the eye, and the slitlike **superior orbital fissure,** through which the cranial nerves controlling eye movements (III, IV, and VI) pass (see Figure 5.10 and **Figure 5.12**). The central part of the sphenoid bone is riddled with air cavities, the **sphenoidal sinuses** (see **Figure 5.13**).

A: *The maxilla.*

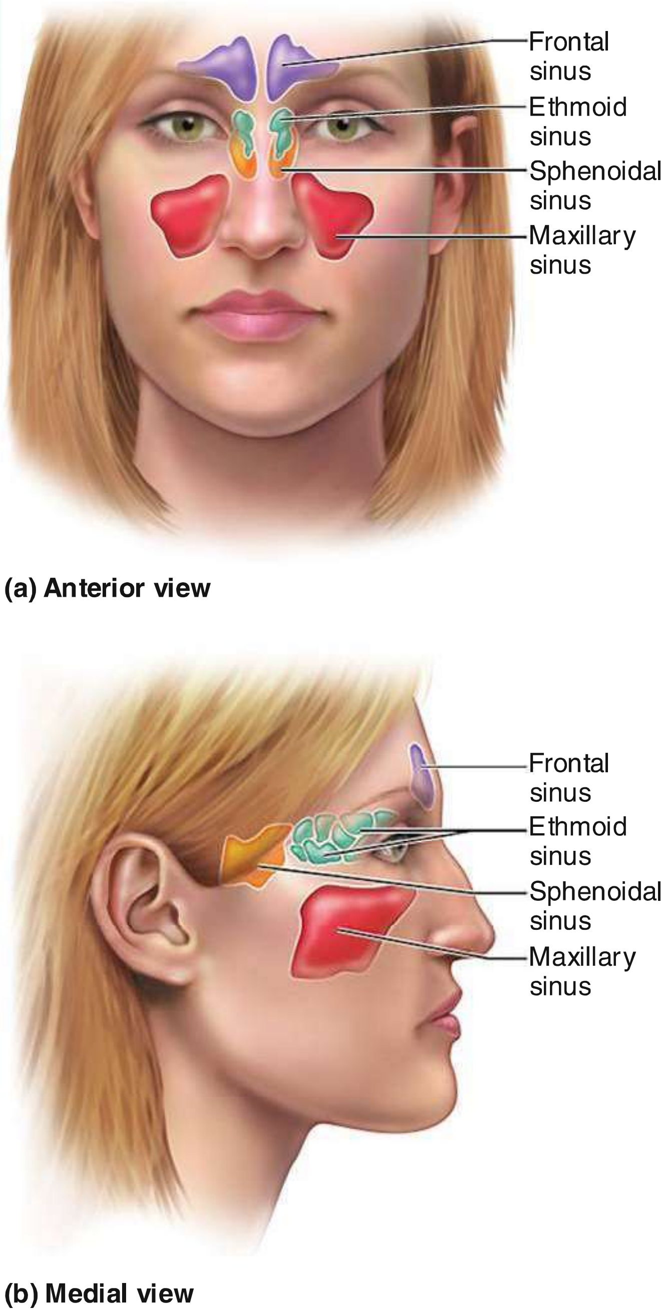


Figure 5.13 **Paranasal sinuses.**

Ethmoid Bone The ethmoid (eth′moid) bone is very irregularly shaped and lies anterior to the sphenoid (Figure 5.12; see also Figures 5.9 and 5.10). It forms the roof of the nasal cavity and part of the medial walls of the orbits. Projecting from its superior surface is the **crista galli** (kris′tah gah′le), literally "cock's comb" (see Figure 5.10). The outermost covering of the brain attaches to this projection. On each side of the crista galli are many small holes. These holey areas, the **cribriform** (krib′rĭ-form) **plates,** allow nerve fibers carrying impulses from the olfactory (smell) receptors of the nose to reach the brain. Extensions of the ethmoid bone, the **superior** and **middle nasal conchae** (kong′ke), form part of the lateral walls of the nasal cavity (see Figure 5.12) and increase the turbulence of air flowing through the nasal passages.

Facial Bones

Fourteen bones compose the face. Twelve are paired; only the mandible and vomer are single. Figures 5.9 and 5.12 show most of the facial bones.

Maxillae The two maxillae (mak-si′le), or **maxillary bones,** fuse to form the upper jaw. All facial bones except the mandible join the maxillae; thus they are the main, or "keystone," bones of the face. The maxillae carry the upper teeth in the **alveolar process.**

Extensions of the maxillae called the **palatine** (pal′ah-tīn) **processes** form the anterior part of the hard palate of the mouth (see Figure 5.11). Like many other facial bones, the maxillae contain **sinuses,** which drain into the nasal passages (Figure 5.13). These **paranasal sinuses,** whose naming reveals their position surrounding the nasal cavity, lighten the skull bones and amplify the sounds we make as we speak. They also cause many people a great deal of misery. Because the mucosa lining these sinuses is continuous with that in the nose and throat, infections in these areas tend to migrate into the sinuses, causing *sinusitis.* Depending on which sinuses are infected, a headache or upper jaw pain is the usual result.

Palatine Bones The paired palatine bones lie posterior to the palatine processes of the maxillae. They form the posterior part of the hard palate (see Figure 5.11). Failure of these or the palatine processes to fuse medially results in *cleft palate.*

Zygomatic Bones The zygomatic bones are commonly referred to as the cheekbones. They also form a good-sized portion of the lateral walls of the orbits, or eye sockets.

Lacrimal Bones The lacrimal (lak′rĭ-mal) bones are fingernail-sized bones forming part of the medial walls of each orbit. Each lacrimal bone has a groove that serves as a passageway for tears (*lacrima* = tear).

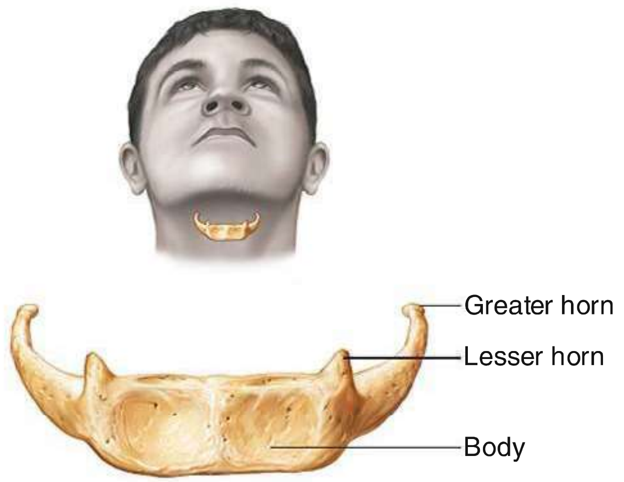


Figure 5.14 Anatomical location and structure of the hyoid bone. Anterior view.

Nasal Bones The small rectangular bones forming the bridge of the nose are the nasal bones. (The lower part of the skeleton of the nose is made up of cartilage.)

Vomer Bone The single bone in the median line of the nasal cavity is the vomer. (*Vomer* means "plow," which refers to the bone's shape.) The vomer forms most of the bony nasal septum.

Inferior Nasal Conchae The inferior nasal conchae are thin, curved bones projecting medially from the lateral walls of the nasal cavity. (As mentioned earlier, the superior and middle conchae are similar but are parts of the ethmoid bone.)

Mandible The mandible, or lower jaw, is the largest and strongest bone of the face. It joins the temporal bones on each side of the face, forming the only freely movable joints in the skull. You can find these joints on yourself by placing your fingers over your cheekbones and opening and closing your mouth. The horizontal part of the mandible (the *body*) forms the chin. Two upright bars of bone (the *rami*) extend from the body to connect the mandible with the temporal bone. The lower teeth lie in *alveoli* (sockets) in the **alveolar process** at the superior edge of the mandibular body.

The Hyoid Bone

Though not really part of the skull, the **hyoid** (hi′oid) **bone** (**Figure 5.14**) is closely related to the mandible and temporal bones. The hyoid bone is unique in that it is the only bone of the body that does not articulate directly with any other bone. Instead, it is suspended in the midneck region about 2 cm (1 inch) above the larynx, where it is anchored by ligaments to the styloid processes of the temporal bones. Horseshoe-shaped, with a *body* and two pairs of *horns,* or *cornua,* the hyoid bone serves as a movable base for the tongue and as an attachment point for neck muscles that raise and lower the larynx when we swallow and speak.

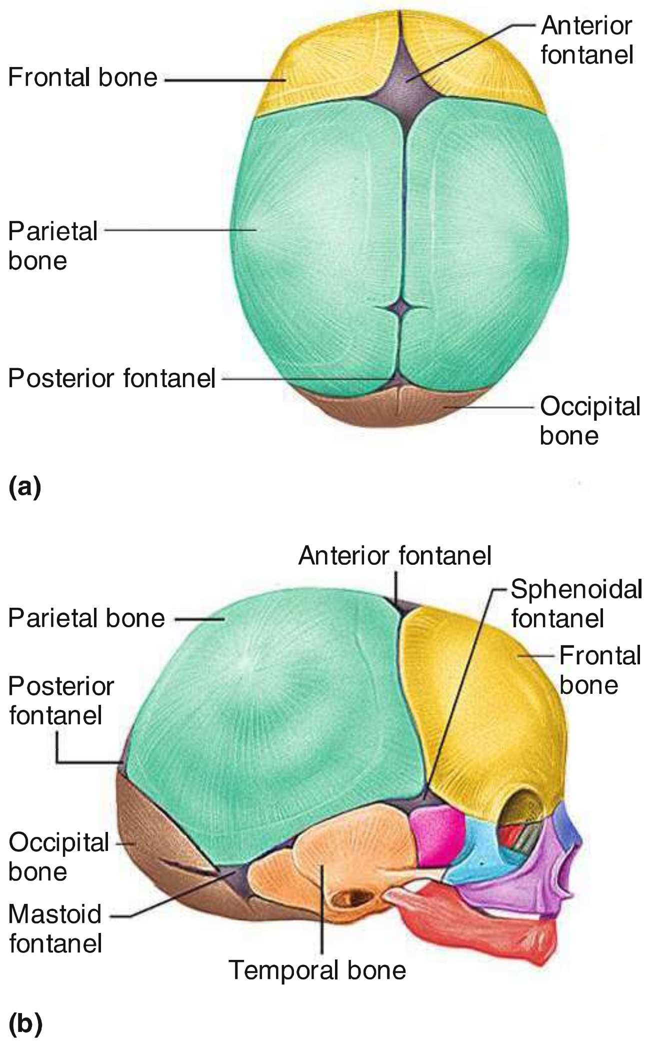


Figure 5.15 The fetal skull. (a) Superior view. **(b)** Lateral view.

Fetal Skull

The skull of a fetus or newborn infant is different in many ways from an adult skull (**Figure 5.15**). As Figure 5.15b illustrates, the infant's face is very small compared to the size of its cranium, but the skull as a whole is large compared to the infant's total body length. The adult skull represents only one-eighth of