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The cavity of the middle ear is a narrow air-filled space. A slight constriction divides it into an upper and a lower chamber, the tympanum (tympanic cavity) proper below and the epitympanum above. These chambers are also referred to as the atrium and the attic, respectively. The middle-ear space roughly resembles a rectangular room with four walls, a floor, and a ceiling. The outer (lateral) wall of the middle-ear space is formed by the tympanic membrane. The ceiling (superior wall) is a thin plate of bone that separates the middle-ear cavity from the cranial cavity and brain above. The floor (inferior wall) is also a thin bony plate, in this case separating the middle-ear cavity from the jugular vein and the carotid artery below. The back (posterior) wall partly separates the middle-ear cavity from another cavity, the mastoid antrum, but an opening in this wall leads to the antrum and to the small air cells of the mastoid process, which is the roughened, slightly bulging portion of the temporal bone just behind the external auditory canal and the auricle. In the front (anterior) wall is the opening of the eustachian tube (or auditory tube), which connects the middle ear with the nasopharynx. The inner (medial) wall, which separates the middle ear from the inner ear, or labyrinth, is a part of the bony otic capsule of the inner ear. It has two small openings, or fenestrae, one above the other. The upper one is the oval window, which is closed by the footplate of the stapes. The lower one is the round window, which is covered by a thin membrane.

Crossing the middle-ear cavity is the short ossicular chain formed by three tiny bones that link the tympanic membrane with the oval window and inner ear. From the outside inward they are the malleus (hammer), the incus (anvil), and the stapes (stirrup). The malleus more closely resembles a club than a hammer, and the incus looks more like a premolar tooth with uneven roots than an anvil. These bones are suspended by ligaments, which leave the chain free to vibrate in transmitting sound from the tympanic membrane to the inner ear.

The auditory ossicles of the middle ear and the structures surrounding them.

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The malleus consists of a handle and a head. The handle is firmly attached to the tympanic membrane from the centre (umbo) to the upper margin. The

head of the malleus and the body of the incus are joined tightly and are suspended in the epitympanum just above the upper rim of the tympanic annulus, where three small ligaments anchor the head of the malleus to the walls and roof of the epitympanum. Another minute ligament fixes the short process (crus) of the incus in a shallow depression, called the fossa incudis, in the rear wall of the cavity. The long process of the incus is bent near its end and bears a small bony knob that forms a loose ligament-enclosed joint with the head of the stapes. The stapes is the smallest bone in the body. It is about 3 mm (0.1 inch) long and weighs scarcely 3 mg (0.0001 ounce). It lies almost horizontally, at right angles to the process of the incus. Its base, or footplate, fits nicely in the oval window and is surrounded by the elastic annular ligament, although it remains free to vibrate in transmitting sound to the labyrinth.

Muscles

Two minuscule muscles are located in the middle ear. The longer muscle, called the tensor tympani, emerges from a bony canal just above the opening of the eustachian tube and runs backward and then outward as it changes direction in passing over a pulleylike projection of bone. The tendon of this muscle is attached to the upper part of the handle of the malleus. When contracted, the tensor tympani tends to pull the malleus inward and thus maintains or increases the tension of the tympanic membrane. The shorter, stouter muscle, called the stapedius, arises from the back wall of the middle-ear cavity and extends forward and attaches to the neck of the head of the stapes. Its reflex contractions tend to tip the stapes backward, as if to pull it out of the oval window. Thus, it selectively reduces the intensity of sounds entering the inner ear, especially those of lower frequency.

Nerves

The seventh cranial nerve, called the facial nerve, passes by a somewhat circuitous route through the facial canal in the petrous portion of the temporal bone on its way from the brainstem to the muscles of expression of the face. A small but important branch, the chorda tympani nerve, emerges from the canal into the middle-ear cavity and runs forward along the inner surface of the pars tensa of the membrane, passing between the handle of the malleus and the long process of the incus. Since at this point it is covered only by the tympanic mucous membrane, it appears to be quite bare. Then it resumes its course through the anterior bony wall, bringing sensory fibres for taste to the anterior two-thirds of the tongue and parasympathetic secretory fibres to salivary glands.

Eustachian tube

The eustachian tube, about 31–38 mm (1.2–1.5 inches) long, leads downward and inward from the tympanum to the nasopharynx, the space that is behind and continuous with the nasal passages and is above the soft palate. At its upper end the tube is narrow and surrounded by bone. Nearer the pharynx it widens and becomes cartilaginous. Its mucous lining, which is continuous with that of the middle ear, is covered with cilia, small hairlike projections whose coordinated rhythmical sweeping motions speed the drainage of mucous secretions from the tympanum to the pharynx.

The eustachian tube helps ventilate the middle ear and maintain equal air pressure on both sides of the tympanic membrane. The tube is closed at rest and opens during swallowing so that minor pressure differences are adjusted without conscious effort. During an underwater dive or a rapid descent in an airplane, the tube may remain tightly closed. The discomfort that is felt as the external pressure increases can usually be overcome by attempting a forced expiration with the mouth and nostrils held tightly shut. This maneuver, which raises the air pressure in the pharynx and causes the tube to open, is called the Valsalva maneuver, named for Italian physician-anatomist Antonio Maria Valsalva (1666–1723), who recommended it for clearing pus from an infected middle ear.