Anatomy, Physiology and Function of the Auditory System

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The human ear consists of the outer ear (pinna or concha, outer ear canal, tympanic membrane), the middle ear (middle ear cavity with the three ossicles malleus, incus and stapes) and the inner ear (cochlea which is connected to the three semicircular canals by the vestibule, which provides the sense of balance). The cochlea is connected to the brain stem via the eighth brain nerve, i.e. the vestibular cochlear nerve or nervus statoacusticus. Subsequently, the acoustical information is processed by the brain at various levels of the auditory system. An overview about the anatomy of the auditory system is provided by Figure 1.

1 • External Ear

The pinna and the initial part of the external auditory canal are constructed from elastic cartilage and show a high interindividual variability. The more internal part of the external ear canal is surrounded by bone. In its rest position, the external ear canal is a bit winded so that the ear drum can only be inspected from outside if this winding is removed (e.g. by softly pulling the pinna to the back and upward). This is utilized when performing otoscopy: The permeability of the external auditory
canal, the shape and consistency of the ear drum, and any suspicious changes in the visible structures are considered by an inspection using a magnifying glass or a microscope. The function of the pinna is to sample the incident sound wave from a larger area into the smaller area of the ear canal (funnel principle, especially for high frequencies). Also, a spectral change (filter) is provided as a function of the incidence direction. The resulting change in timbre as a function of incidental direction can be utilized for localization of the sound source from where the sound is emitted. (Additionally, interaural differences in level and in arrival time occur that are utilized by the brain to perform a very exact localization in the horizontal plane by comparing the input to both ears. However, the interaural information has to be supplemented by the spectral changes provided by the pinna and other structures to avoid front/back confusions.) At low frequencies, the shape of the upper part of the body and the head is primarily responsible for

**Figure 1** Overview of the anatomy of the outer ear, middle ear and inner ear (modified from Kollmeier, 1997).