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## Auditory and vestibular systems

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### Summary

The middle and inner ear of the extant monotremes show anatomical features that are reminiscent of early mammals like the multituberculates, but other features of the ears of modern monotremes are clearly derived characters. Although hearing is probably not of major behavioural importance for the platypus, hearing in the short-beaked echidna may be important for detection of invertebrates like termites. In both the platypus and echidna, hearing is optimal for frequencies between 4 kHz and 5 kHz and may be superior for bone conduction through the mandible and maxilla rather than air conduction, consistent with the use of the echidna snout as a thrust probe for locating invertebrate prey. The monotremes have many of the same central components of the auditory and vestibular pathways that have been identified in therians, but

some components, e.g. the superior olivary nuclear complex and the medial geniculate nucleus, are difficult to definitively identify. The auditory cortex is small in both the platypus and echidna, both in terms of absolute and relative size, but there may be two separate auditory areas, each with a tonotopic organisation. Based on the pace of structural maturation, the inner ear of the young monotreme is unlikely to be functionally capable until well into lactational phase life, although the macula of the utricle may be able to assist with orientation around the time of hatching.

### Overview of the auditory and vestibular systems

The vertebrate ear is divided into three parts. The external ear consists of an external auditory canal