On the Periodically Aggregated Particles on the Fracture Face of the Cochlear Hair Cell

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Summary. By means of the freeze-fracture technique, the membrane specialization of the cochlear hair cell of guinea pigs was studied. Periodically aggregated particles were revealed on the PF face of the plasma membrane of the outer hair cell. The particles were around 12nm in diameter and 10 to 17nm in center-to-center spacing. Their arrangement was hexagonal, orthogonal or parallel. Possible involvement of this structure in the electrical excitability of the membrane was discussed.

Material and Method

Adult guinea pigs of both sexes were sacrificed by cervical dislocation. The temporal bone was quickly removed and the bony cochlea was opened in a solution containing 2.5% glutaraldehyde and 0.1M phosphate buffer (pH 7.4) and was left in the same fixative for about 4hrs. During this time the longitudinal segments of the organ of Corti were dissected under microscopic control. For freeze-fracturing the specimens were equilibrated with 40% glycerol in saline, then frozen in liquid nitrogen. Platinum carbon replicas were made in the freeze-fracture apparatus devised by one of the authors (Morioka et al., 1973) and examined with a Hitachi 11Ds electron-microscope.

Results

On the replicas obtained the outer hair cell and the Deiter's cell could easily be distinguished by their specific cytoplasmic organelles, the arrangement of the cuticle, gap junctions and tight junctions. On the PF face of the plasma membrane of the outer hair cell at the infracuticular portion, at least three groups of periodically aggregated particles were observed (Fig. 1, 2). The diameter of the particles and center-to-center spacing were around 12nm and from 10 to 17nm respectively. The
Fig. 1. Freeze-fracture electron micrograph of outer hair cell (H) and Deiter's cell (D). Tight junction (tj) is seen between Deiter's cell and outer hair cell. Gap junction (gj) on the EF face (EF) of the plasma membrane of Deiter's cell (D) is observed. Note the complementary structure on the PF face (PF) of the plasma membrane of the juxtaposed cell. cu Cuticle × 26,000. Arrow in left upper corner indicates the direction of shadowing (also in Figure 2).
Fig. 2. Higher magnification of part of Figure 1 circumscribed by solid line. Three groups of periodically aggregated particles (arrows) on the PF face (PF) of the plasma membrane of hair cell. No complementary structure for structure a is seen on the EF face of the plasma membrane of juxtaposed cell (arrow head). Note hexagonal, orthogonal and parallel arrangement of particles for structures a, b and c respectively. $\times 58,500$ Inset: Higher magnification of structure a and b. $\times 103,000$
arrangement of the particles was hexagonal, orthogonal or parallel. In some cases particle free areas were found near the center of the aggregates. The complementary structures on the juxtaposed plasma membrane were not observed.

**Discussion**

One of the well known particle aggregations is the gap junction, of which two types have been distinguished so far (Andrew, 1972; Rash et al., 1974). The most frequently encountered type I gap junction, which can be observed on the Deiter's cell plasma membrane in Figure 1, possesses 8 to 9 nm particles with a center-to-center spacing of 9 to 10 nm. The type II gap junction is always found in close association with type I junction and possesses 10 to 11 nm particles with center-to-center spacing of 19 to 20 nm. The arrangement of the particles is usually hexagonal and complementary structures on the juxtaposed plasma membrane are frequently encountered (Fig. 1). Considering the size, the center-to-center spacing of the particles and their arrangement, the particle aggregations presented here should have been differentiated from gap junctions. Closely resembling structures have been demonstrated on the PF face of the plasma membrane of the inner hair cell (Jahnke, 1975), on the electrically excitable nonjunctional sarcolemma of mammalian skeletal muscle fibers (Rash et al., 1974) and on the PF face of the sarcolemma of the frog sartorius muscle (Ishikawa, 1975). The present structure can be related to the electrical excitability of the hair cell. Further studies including application of the double replica technique are needed to obtain more precise information.

**References**


