動物生理学 III Handout No. 11

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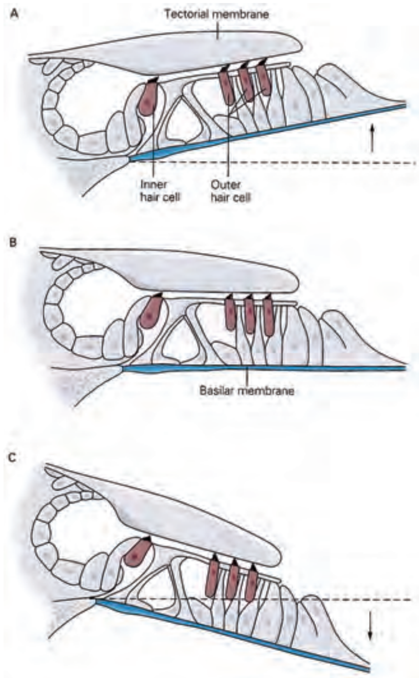

Figure 30-6 **Hair cells in the cochlea** are stimulated when the basilar membrane is driven up and down by differences in the fluid pressure between the scala vestibuli and scala tympani. Because this motion is accompanied by shearing motion between the tectorial membrane and organ of Corti, the hair bundles that link the two are deflected. This deflection initiates mechanoelectrical transduction of the stimulus. (Adapted from Miller and Towe 1979.)
A. When the basilar membrane is driven upward, shear between the hair cells and the tectorial membrane deflects hair bundles in the excitatory direction, toward their tall edge.
B. At the midpoint of an oscillation the hair bundles resume their resting position.
C. When the basilar membrane moves downward, the hair bundles are driven in the inhibitory direction.

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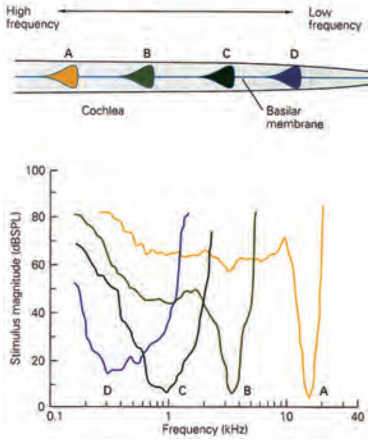

Figure 30-7 **Tuning curves for cochlear hair cells.** To construct a curve, the experimenter presents sound at each frequency at increasing amplitudes until the cell produces a criterion response, here 1 mV. The curve thus reflects the threshold of the cell for stimulation at a range of frequencies. Each cell is most sensitive to a specific frequency, its characteristic (or best) frequency. The threshold rises briskly (sensitivity falls abruptly) as the stimulus frequency is raised or lowered. (From Pickles 1988.)

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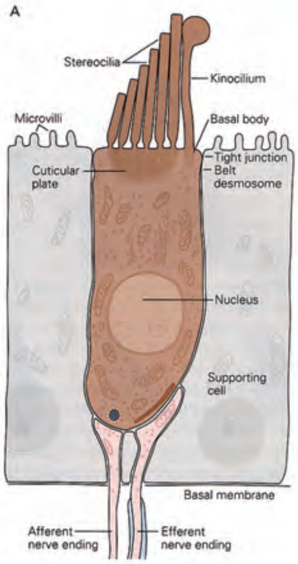

Figure 37-7 **Structure of a vertebrate hair cell.**
A. The epithelial character of the hair cell is evident in this drawing of the sensory epithelium from a frog's internal ear. The cylindrical hair cell is joined to the adjacent supporting cells by a functional complex around its apical perimeter. From the cell's apical surface extends the hair bundle, the mechanically sensitive organelle. Afferent and efferent synapses occur upon the basolateral surface of the plasma membrane.

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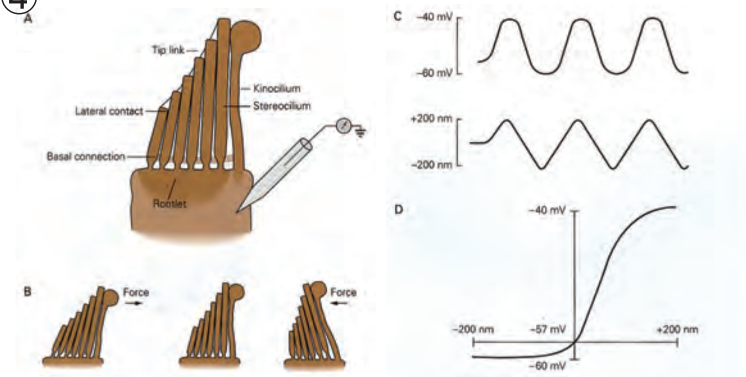

Figure 31-2 **Mechanical sensitivity of a hair cell.**
A. A schematic drawing of a hair cell with a recording electrode inserted into its cytoplasm.
B. Application of a mechanical force to the hair bundle deflects this elastic structure.
C. When the top of a hair bundle is displaced back and forth by a stimulus probe (lower trace), the opening and closing of mechanically sensitive channels produces an oscillatory receptor potential (upper trace).
D. The sigmoidal relation between hair-bundle deflection (abscissa) and receptor potential (ordinate) is a stimulated hair cell.

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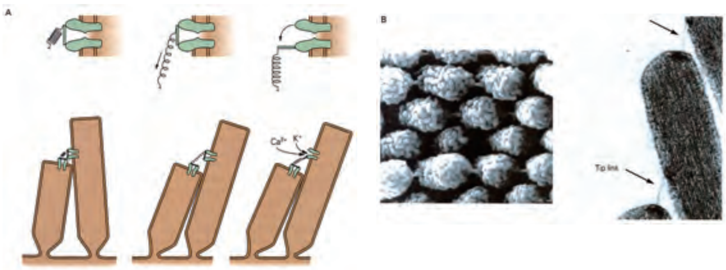

Figure 31-3 **A model for the mechanism of mechano-electrical transduction by hair cells.**
A. Top: The ion channels that participate in mechanoelectrical transduction in hair cells are gated by elastic structures in the hair bundle. The channel is assumed to be a membrane-spanning protein with a cation-selective pore. Ion permeation through this channel is regulated by a molecular gate, whose opening and closing is controlled by the tension in an elastic element, the gating spring, that senses hair-bundle displacement. (Adapted from Howard and Hudspeth 1988.) Bottom: When the hair bundle is at rest each transduction channel clatters between closed and open states, spending most of its time shut (leftl. Displacement of the bundle In the positive direction increases the tension in the gating spring, here assumed to be a tip link, attached to each channel's molecular gate (middle). The enhanced tension promotes channel opening and the influx of canons, thereby producing a depolarizing receptor potential (right). (Adapted from Hudspeth 1989.)
B. The links that connect each stereociliary tip to the side of the longest adjacent stereocilium are visible in this scanning electron micrograph of a hair bundle's top surface (left) and transmission electron micrograph (right). Although each tip link is only 3 nm in diameter, the links appear stouter in the illustration on the left because of metallic coating during specimen preparation. (From Assad et al. 1991 and Hudspeth and Gillespie 1944.)

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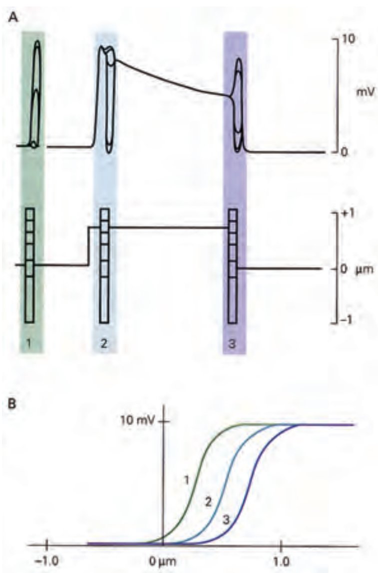

Figure 31-4 **Adaptation of mechano-electrical transduction in hair cells.**
A. The hair bundle is subjected to a family of deflections in a series of tests. Test stimuli of various sizes are applied before (1) and at two times during a bundle deflection maintained for 100 ms (2-3). The family of receptor potentials reveals a rapid depolarization at the outset, followed by gradual decline toward a plateau during maintained stimulation.
B. The relation between displacement and the electrical response of the hair bundle before and during the maintained displacement. As adaptation proceeds, the sigmoidal relation between bundle displacement and receptor potential shifts along the abscissa without substantial changes in the curve's shape or amplitude. This result implies that, during adaptation to a protracted stimulus, a hair bundle's range of mechanical sensitivity migrates toward the position at which the bundle is held.