Supporting Material

Micro-structures in the organ of Corti help outer hair cells form traveling waves along the cochlear coil

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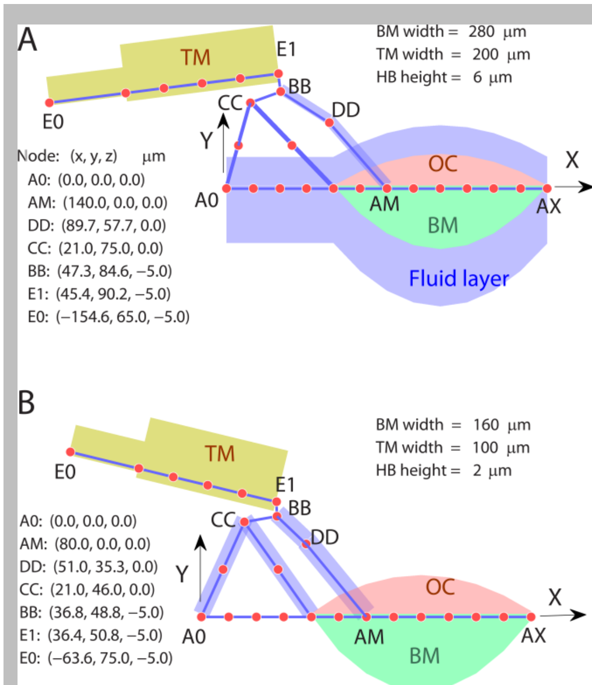

Figure S1. Finite element model. (A) The apex model near Z = 10 mm. (B) The base model near Z = 2 mm. Each radial section has 25 nodes (red dots). Three-dimensional coordinates of 8 characteristic nodes were shown next to each model (A0, AM, AX, BB, CC, DD, E0 and E1). Note that three nodes are at different plane from the others ($Z = Z_0$ - 5 µm for BB, E0 and E1) due to outer hair cell tilt. The sections are 10 µm apart along the Z-axis. These sections are bound by longitudinal elements along the TM, BM, RL (through nodes CC and BB), and through Deiters cell-outer hair cell junction (node DD). Additionally, the DCpp connect node DD of a section to node BB of two sections later (i.e., DD at $Z = Z_0 + 0$ and BB at $Z = Z_0 -$ 20 µm). The geometry gradually changes along the Z-direction by interpolating the two coordinates at Z=10 mm (**A**) and Z=2 mm (**B**). The shaded areas indicate the primary mass components—TM, BM, organ of Corti (OC) and fluid layer.

Table S1. Mechanical properties

Structure	Parameter	Apex (Z=10 mm)	Base (Z=2 mm)	Reference
Basilar membrane†	Width (A+P)	280	160	(2-4)
	Stiff Thick (A, P)	0.175, 0.7	0.8, 3.2	
	Mass Thick	55	35	*
	Y_{Mx}, Y_{Mz}	1000, 0.15	1000, 0.3	
OHC soma	Diameter	8	8	(5)
	Length	50	20	
	Y_M	0.015	0.015	(6)
OHC hair bundle	Height	6	2	(7-10)
	Stiffness	3	40	
Inner and Outer Pillar cells	Diameter	2	8	(11)
	Y_M	10	10	**
Deiters cell (base, process)	Diameter	10, 1	10, 1.5	(12)
	Y_M	0.5, 3	0.5, 3	***
Reticular lamina (tunnel of Corti, OHC)	Thickness	5, 1	5, 2	
	Y_{Mx}, Y_{Mz}	10, 0.2	2, 0.05	
Tectorial membrane (root, body) ‡	Total width	200	100	(3, 4, 13, 14)
	Thickness	25, 50	15, 30	
	Y_{Mx}	0.01,0.0025	0.1, 0.025	
	Y_{Mz}	$1/20*YM_x$	$1/20*YM_x$	

Dimensions in μm, areas in μm^2, Young's modulus, Y_M, in MPa, and stiffness in mN/m.

* Mass thickness represents the thickest part of the basilar membrane (cf. Edge et al., 1998). The mass thickness is used to create mass matrix, while stiffness thickness used to formulate stiffness matrix.

** Tolomeo *et al.*, estimated higher Young's modulus and low shear modulus (anisotropic properties). This work used isotropic elements for pillar cells. Because the pillar cells are much stiffer than any other elements in the organ of Corti, the isotropy affected the results minimally.

*** Dulon *et al.*, measured the bending stiffness of the Deiters cell phalangeal process (0.015~0.44 mN/m, N=7). We estimated Young's modulus that results in similar bending stiffness as theirs (0.003 mN/m at the apex and 0.15 mN/m at the base).

†The basilar membrane is divided into two parts, the arcuate zone (BM_A) beneath the tunnel of Corti and the pectinate zone (BM_P), BM_A being 1/3 of the total width. The thickness is that of the fiber layer(s) running radially.

‡ A radial section of the tectorial membrane is divided into two parts, the root attached to the spiral limbus and the body overlying the OHC stereocilia, the root being 1/3 of the total TM length and half the thickness of the body.

Table S2. Electrical and mechano-transduction properties of the outer hair cell

Symbol		Apex	Base	Description	Reference
H	(μm)	6	2	Hair bundle height	(9)
γ	-	0.11	0.25	Elongation of the gating spring per unit displacement of hair bundle tip	(7)
A	(ms^{-1})	10	100	Channel activation rate constant	(15)
k_{GS}	(mN/m)	6	6	Gating spring stiffness	(7)
b	(nm)	0.4	0.6	Gating swing	(7)
c	(nm)	0.7	0.7	Ca binding modification	(7, 16)
k_B	($ms^{-1}\mu M^{-1}$)	0.4	0.4	Ca binding coefficient	(7, 16)
K_D^C	(μM)	20	100	Ca dissoc. const. when a channel is closed	(7)
K_D^O	(μM)	1	1	Ca dissoc. const. when a channel is open	(7)
C_0	(μM)	1	1	[Ca^{2+}] near the channel when a channel remains closed	(17, 18)
C_1	(μM)	20	100	[Ca^{2+}] near the channel when a channel remains open	(17, 18)

Supporting References

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