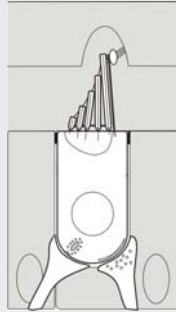


Transduction in vertebrate hair cells

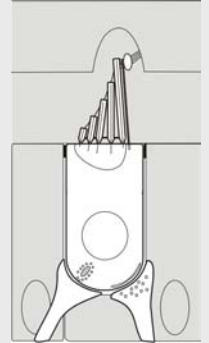
Ruth Anne Eatock, eatock@bcm.tmc.edu, 713-798-5145

- Introduction
- Mechanoelectrical transduction
- Adaptation
- Tuning

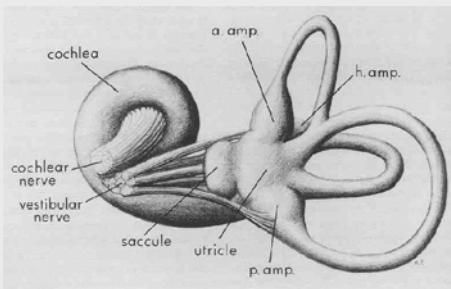


Transduction in vertebrate hair cells

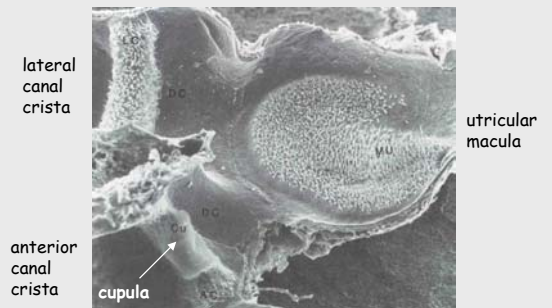
- Movement of extracellular matrices
→ Deflection of hair bundle (ΔX_B)
- Mechanoelectrical transduction
 - $\Delta X_B \rightarrow \Delta I_m$ 'transduction current'
 - $\Delta I_m \rightarrow \Delta V_m$ 'receptor potential'
- Synaptic transmission
 - $\Delta V_m \rightarrow \Delta(\text{quanta}) \rightarrow \Delta(\text{epsps})$
- Spike generation
 - $\Delta(\text{epsps}) \rightarrow \Delta(\#\text{Aps/s})$



The mammalian inner ear



Hair cells are epithelial cells



hamster; Hunter-Duvar & Hinojosa 1984

Frog saccule, D.P. Corey

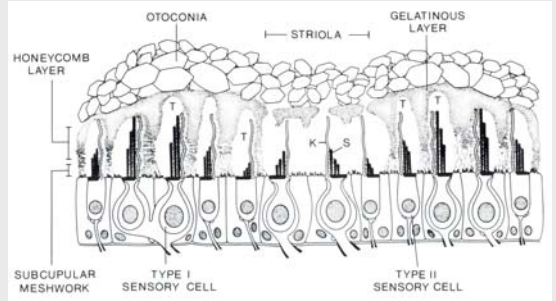


Turtle utricle, striola
E.H. Peterson

Hair bundles

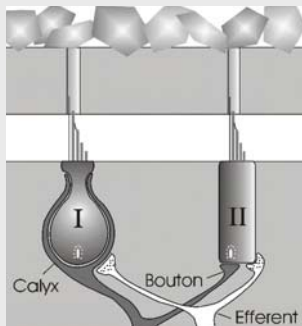
Mouse saccule, Denman-Johnson & Forge

Extracellular matrices determine stimulus modality

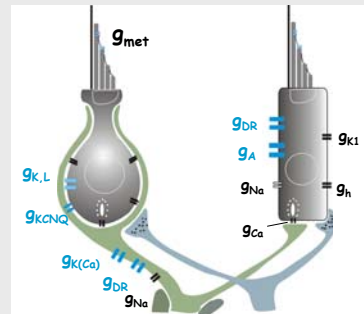


Lim, 1984

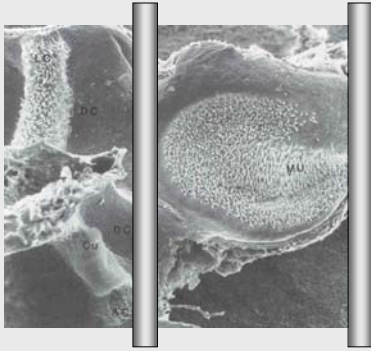
Otolith organ



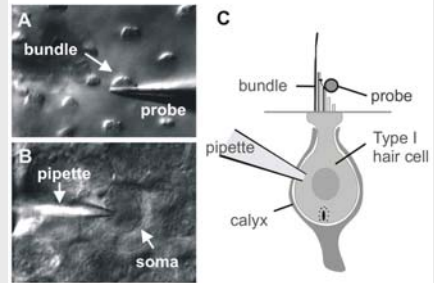
Mechano- and voltage-gated ion channels



Transduction experiments

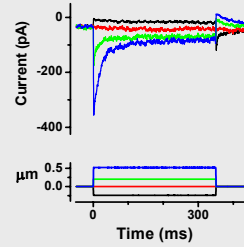


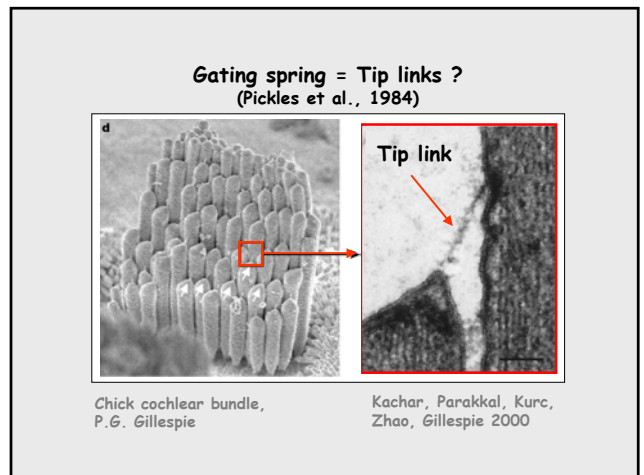
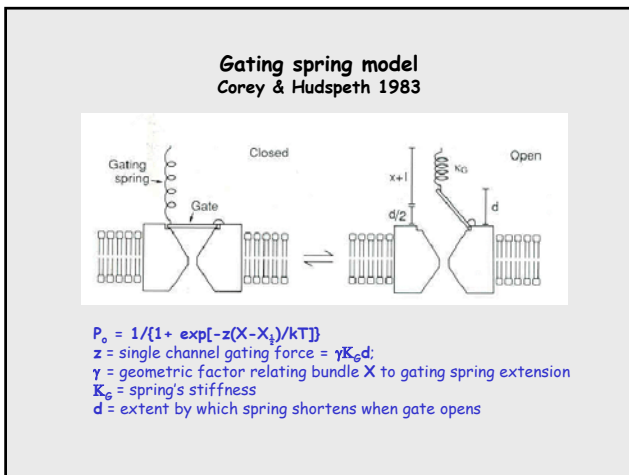
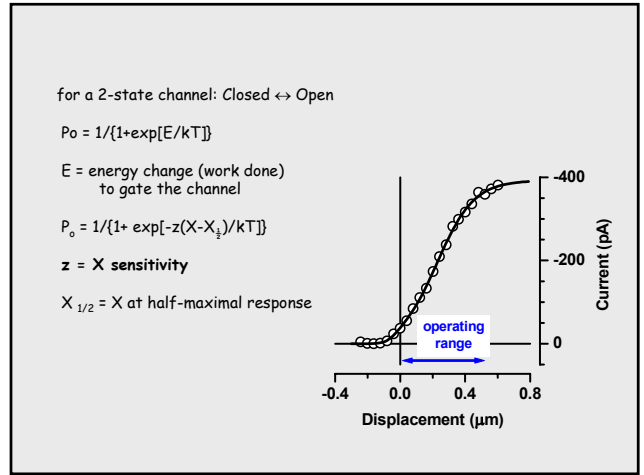
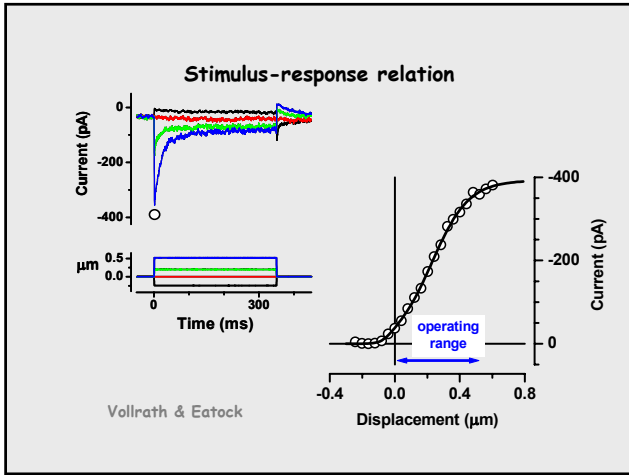
Recording transduction currents



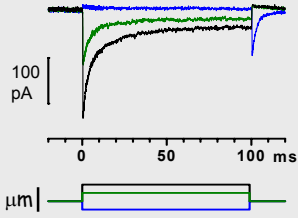
Movies

Step responses



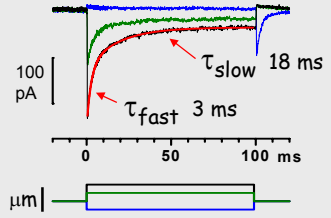


Adaptation



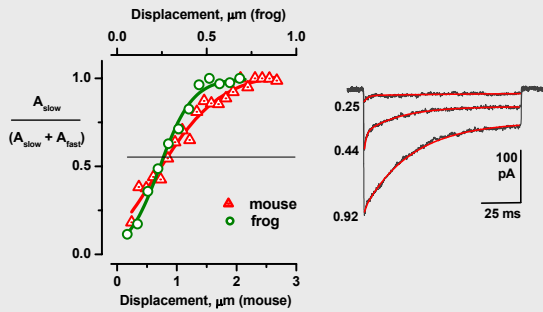
Melissa Vollrath

Fast and slow feedback on transduction



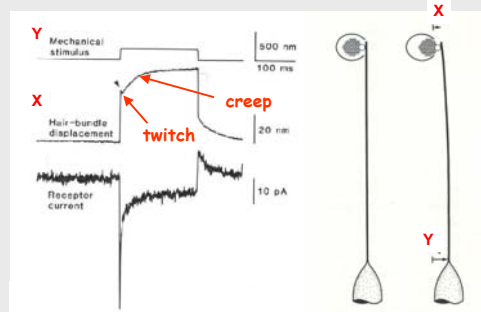
Melissa Vollrath

Two components dominate over different stimulus ranges



Vollrath & Eatock 2003

Mechanical correlates of feedback

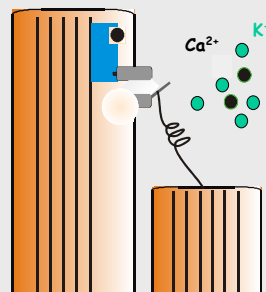
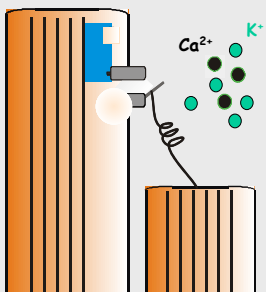
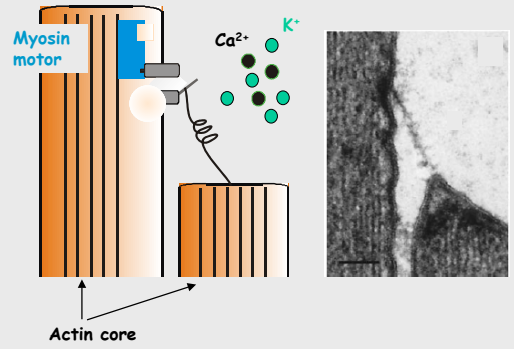


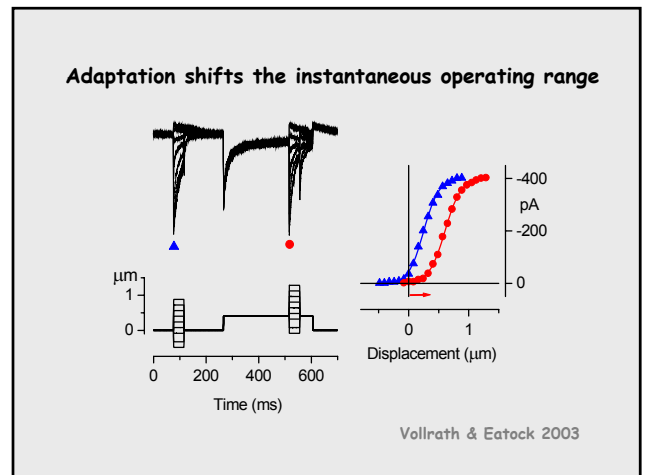
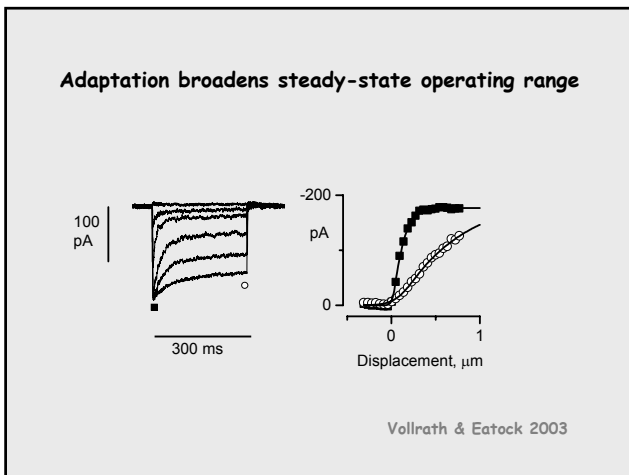
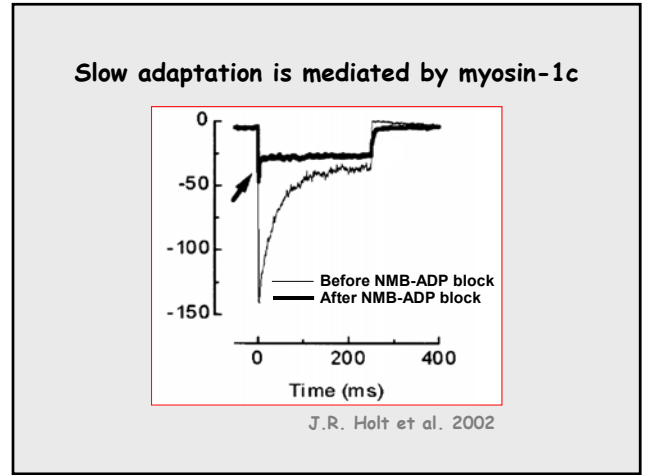
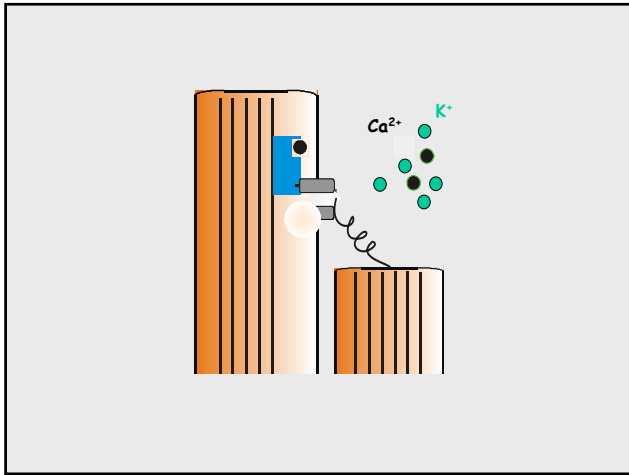
Frog saccule; Howard & Hudspeth 1987

Models of feedback (adaptation/amplification)

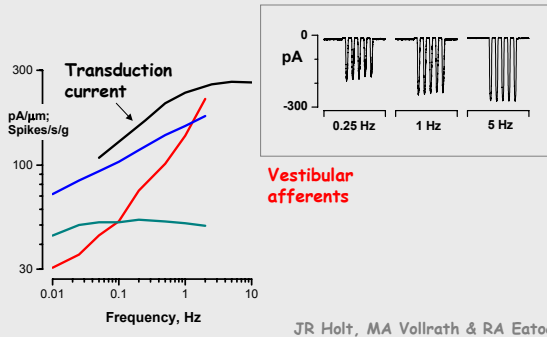
- Slow feedback: Motor model
 - Howard & Hudspeth 1987
 - Assad & Corey 1991

Motor model of slow feedback





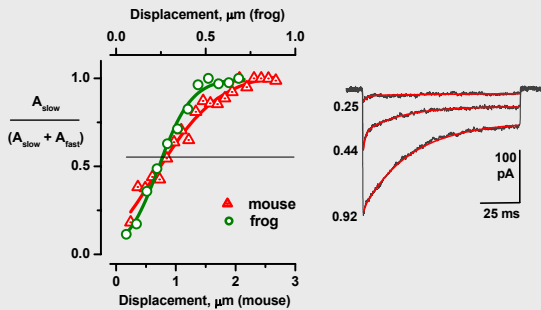
Filtering by adaptation



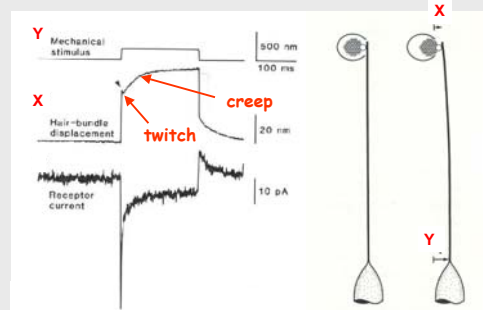
Models of feedback (adaptation/amplification)

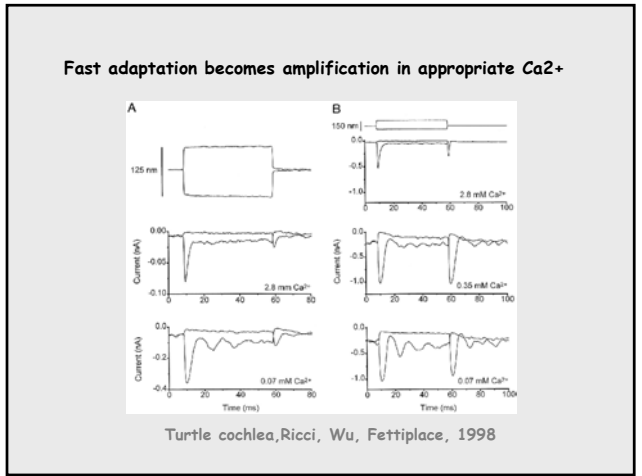
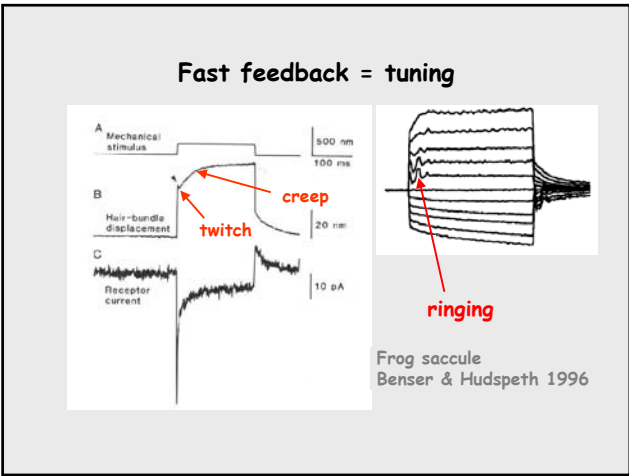
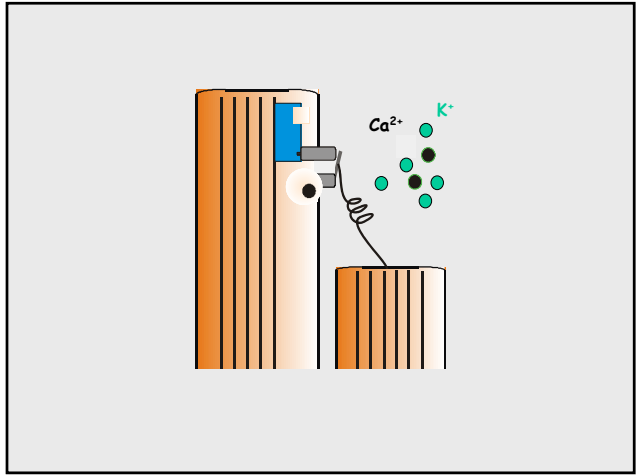
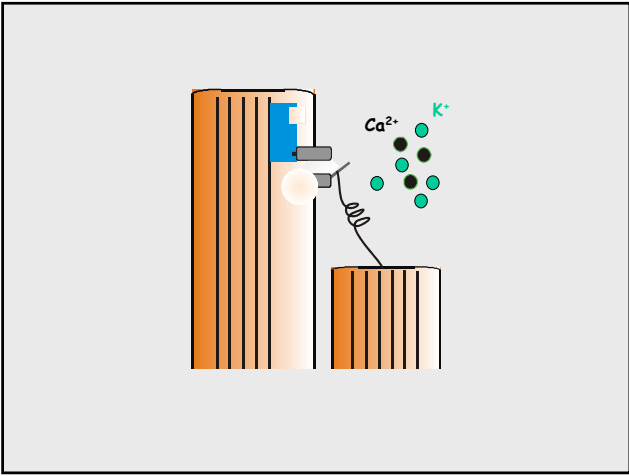
- Slow feedback: Motor model
 - Myosin-1c mediated
 - Broadens steady-state operating range,
 - Shifts instantaneous operating range
- Fast feedback: Channel re-closure
 - Howard & Hudspeth 1987
 - Crawford, Evans, Fettiplace 1989

Two components dominate over different stimulus ranges

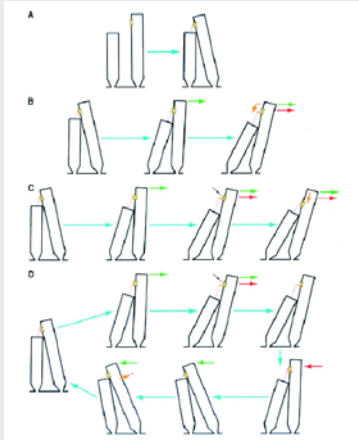


Mechanical correlates of feedback





Transduction and bundle movements

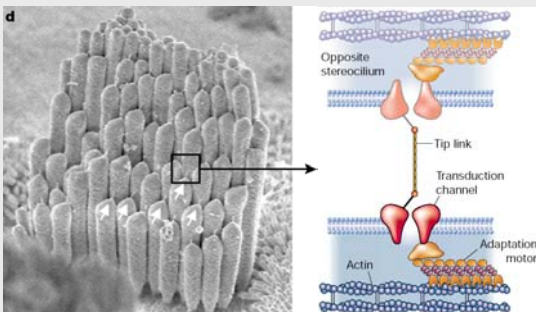


Hudspeth et al. 2000

Models of feedback (adaptation/amplification)

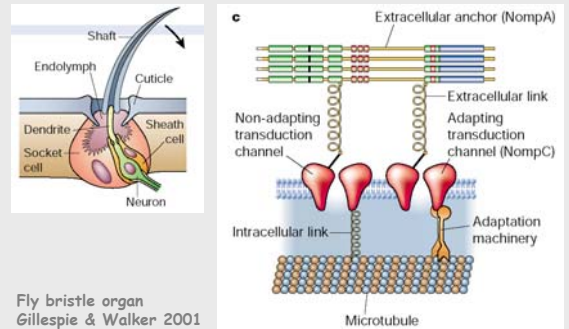
- **Slow feedback: Motor model**
 - Ca^{2+} - , Myosin-1c mediated
 - Broadens steady-state operating range
 - Shifts instantaneous operating range
- **Fast feedback: Channel re-closure**
 - Ca^{2+} -mediated
 - Dominates at small stimulus levels
 - Amplifies at specific frequencies (tuning)

Hair cell model of mechanotransduction



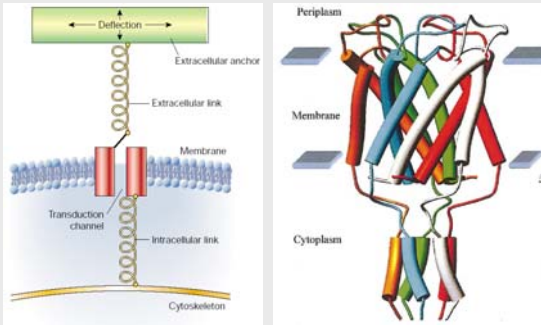
Gillespie & Walker 2001

Invertebrate analogues (homologues?)



Fly bristle organ
Gillespie & Walker 2001

Mechanotransduction models



A. Tethered (hair cell model)

B. Activated by membrane stretch (bacterial channel model)

Transduction in vertebrate hair cells

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- Introduction
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