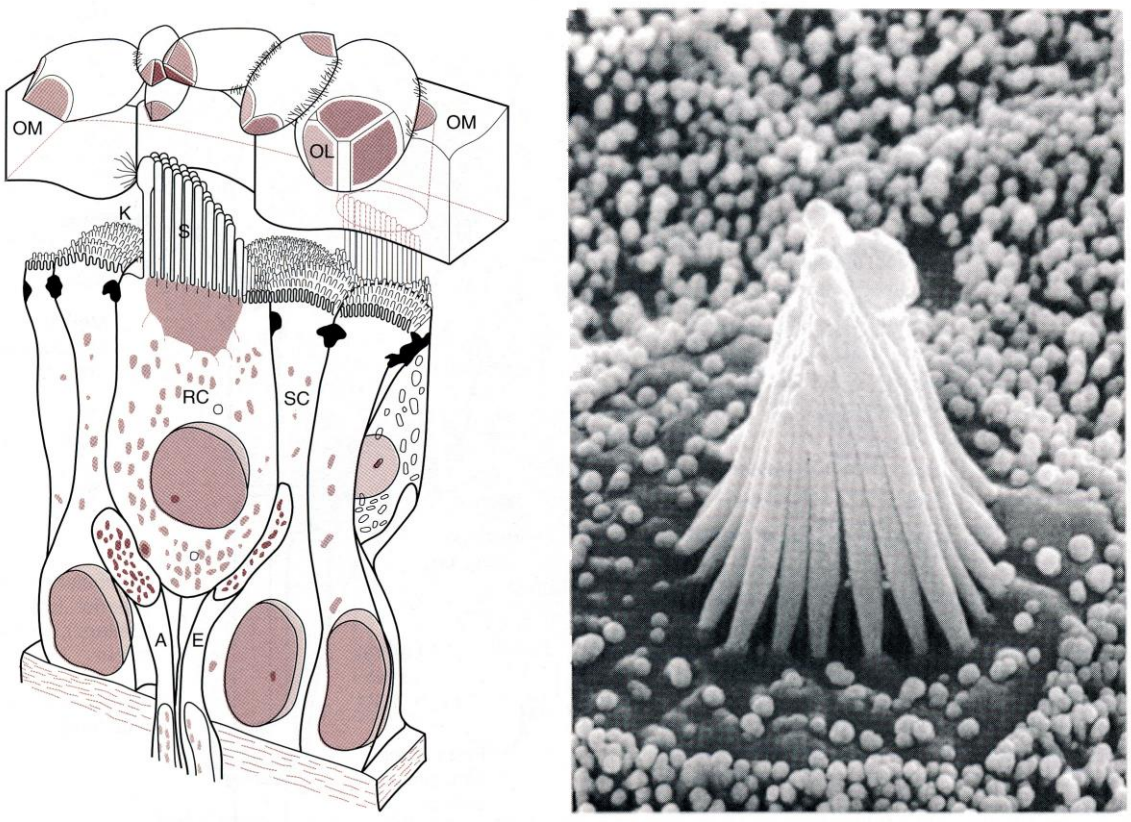
Hair Cell Function

Last updated: May 11, 2019

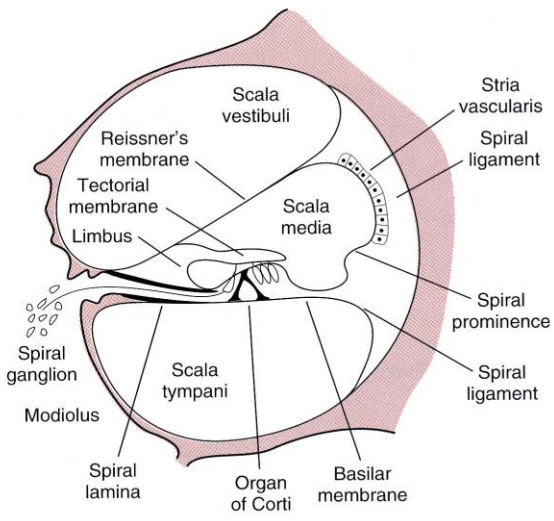
Hair cell STRUCTURE:



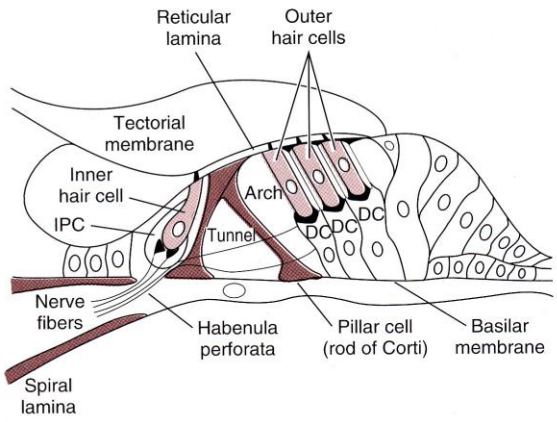
Left: Structure of a hair cell in the saccule of a frog, showing its relation to the otolithic membrane (OM). K, kinocilium; S, stereocilia; RC, hair cell with afferent (A) and efferent (E) nerve fibers; OL, otolith; SC, supporting cell. (Reproduced, with permission, from Hillman DE: Morphology of peripheral and central vestibular systems. In: Llinas R, Precht W [editors]: *Frog Neurobiology.* Springer, 1976.) **Right:** Scanning electron photomicrograph of processes on a hair cell in the saccule of a frog. The otolithic membrane has been removed. The small projections around the hair cell are microvilli on supporting cells. (Courtesy of AJ Hudspeth.)

Source of picture: William F. Ganong "LANGE Review of Medical Physiology", 21st ed. (2003); Publisher: McGraw-Hill / Appleton & Lange; ISBN-10: 0071402365; ISBN-13: 978-0071402361 >>

Corti organ STRUCTURE:



Cross section of the cochlea, showing the organ of Corti and the three scalae of the cochlea.



Structure of the organ of Corti, as it appears in the basal turn of the cochlea. DC, outer phalangeal cells (Deiters' cells) supporting outer hair cells; IPC, inner phalangeal cell supporting inner hair cell.

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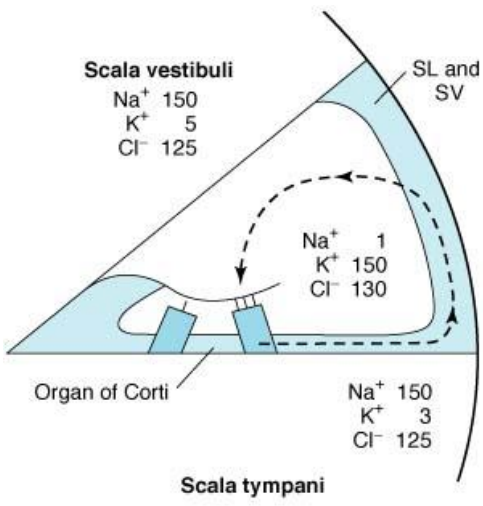
Hair cell's membrane potential is -60 mV; hair processes generate changes in membrane potential proportionate to displacement direction:

- when stereocilia are pushed **toward kinocilium**, membrane potential is decreased to -50 mV.
- when bundle of processes is pushed **away from kinocilium**, cell is hyperpolarized.
- displacing processes in direction ***perpendicular to this axis*** provides no change in potential.

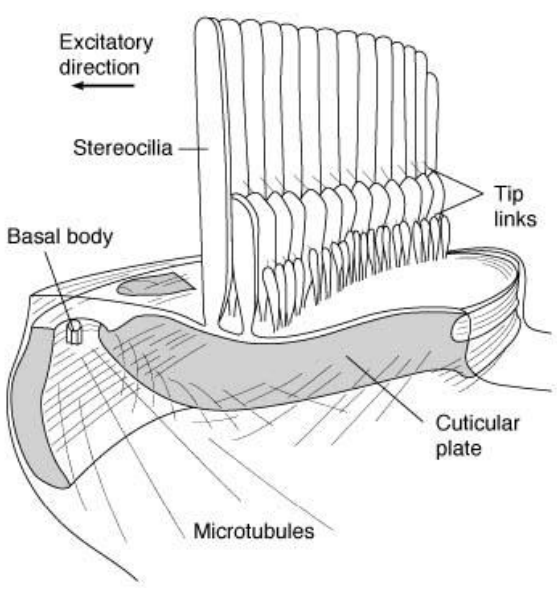
- **processes** of hair cells project into ENDOLYMPH whereas **bases** are bathed in PERILYMPH.
- PERILYMPH is formed mainly from ***plasma*** - resembles extracellular fluid.
- ENDOLYMPH is formed by ***stria vascularis*** and has high K^+ concentration and low Na^+ concentration; in addition, stria vascularis has unique **electrogenic K^+ pump** → ENDOLYMPH of scala media is electrically positive by +85 mV relative to PERILYMPH of scala vestibuli & scala tympani.



SL, spiral ligament. **SV**, stria vascularis. **dashed arrow** indicates path by which K^+ recycles: hair cells → supporting cells → spiral ligament → secreted back into endolymph by stria vascularis.

Very fine processes called **TIP LINKS** tie tip of each stereocilium to side of its higher neighbor.

- at junction, higher stereocilium has **mechanically sensitive cation channels** (α-subunit of epithelial sodium channel may be involved);
- tension on each of channels is adjusted by "adaptation motor" made up of myosin in higher stereocilium;
- when shorter stereocilia are pushed toward higher, **open time of channels** increases; stereocilia displacement in opposite direction reduces channel open time.
- channels are ***relatively nonspecific*** cation channels, but since they are bathed in ENDOLYMPH (high K^+ concentration + strongly positive relative to cell inside → electrochemical gradient*), K^+ enters hair cell when they are open → hair cell depolarization → Ca^{2+} enters cell → excitatory synaptic transmitter (probably **GLUTAMATE**) release → afferent neuron depolarization.
- K^+ that enters hair cells is recycled back to ENDOLYMPH.



Arrow indicates direction in which pushing cilia increases ion influx into hairs.

* in general, there is no K^+ concentration gradient between endolymph and hair cell interior, but at least it does not impede K^+ movement into cell.

BIBLIOGRAPHY for ch. "Otology" → follow this LINK >>