20180118 COGS 107b Lecture Notes

Cabinet COGS107b Lecture Notes

The Vestibular System

Functions:

- Postural Reflexes
  - Detecting a falling motion and correcting

- Gaze adjustment
- Assessment of Self Motion
  - Path Integration: maintaining distance and direction of movement, even when eyes are closed.

The hair cell receptor

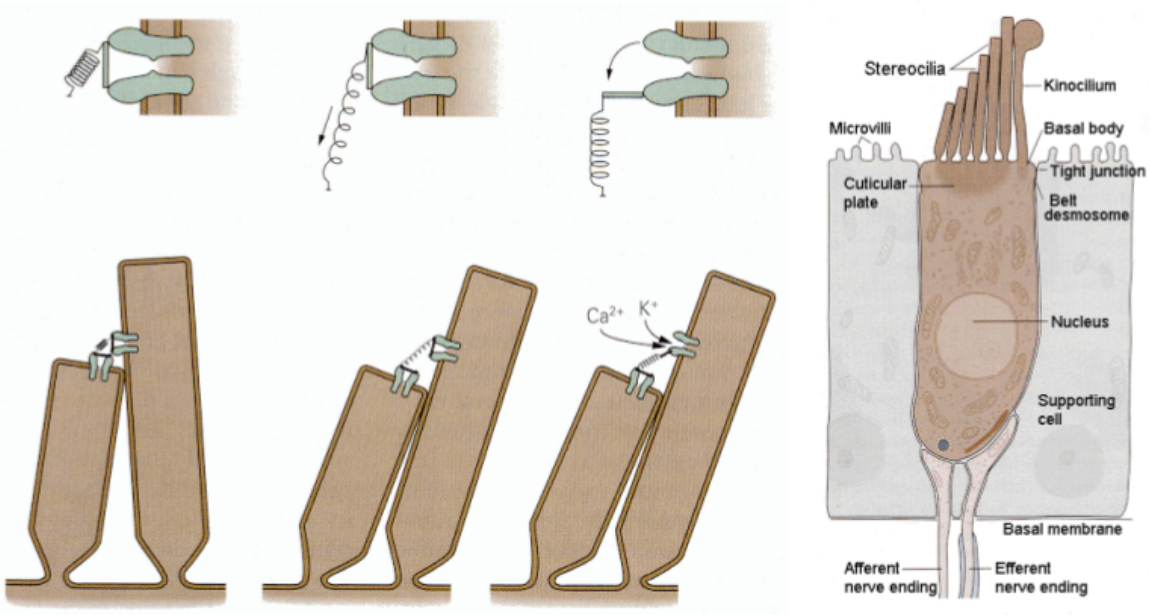
Cillia: hair cells

Transduction of both head motion (vestibular system) and sound waves (auditory system) into neural signals

Mechanical vibration → Electrical signal

The ion concentration differentials between the inside and outside of stereocillia are unusual, there's more K^+ on the outside than inside.

Depolarization involves K^+ *influx*.



Cillia are arranged low to high with the kinocillium at the end (top). Bending of the cillium towards the high end opens ion channels, thereby depolarizing it.

Bending of the cillium towards the low end causes hyperpolarization. The degree of hyperpolarization is not as high as the degree of depolarization.

The more the hair bends, the more channels that will open, the more the release of glutamate.

Can die off without regeneration.

The inner ear

Vestibular system

Hair cells in the semicircular canals and the otolith organs

Hair cells = transient

Otolith organs = persistent

Semicircular organs

Three on each side of the brain.

Composed of:

- Utricle
- Saccule

Hair cells are embedded in endolymph which is embedded in the cupula which moves with the extracellular fluid.

The cupula between the left/right sides of the head are organized as opposites. One side produces excitation while the other produces inhibition.

Linear movement: straight relative to the gravity
Radial movement: Turning and tilting head relative to trunk of body.

Ultricle and Saccule

Registration of static head position(relative to ground/ gravity), orthgonality, and the hair cell population code

When you tilt your head, gravity pulls the gelatinous cap down, causing depolarization of the hair cells

- Utricle: Linearly Horiztonal movement
    - Hair cells are oriented upwards relative to head
    - Some of the hair cells have the kinocillium towards the front/back/left/right (and a continuous degree of difference between those directions) of the head.
- Saccule:
    - Hair cells are oriented forward relative to the head (this detects up/down motion)
    - Some of the hair cells have the kinocillium up/down

Vestibular Afferents

Pathways to the brain and spinal cord

Integrating vestibular signals

The vestibulo-ocular reflex

Adjusting and maintaining gaze during head movemnets

When maintaining gaze, moving the head in one direction causes movement of the eyes in the opposite direction.

The semicircular canals (horizontal), project onto the vestibular neurons in the brain stem which then project directly onto the eye muscle (rectus lateralis).

The ubiquitous ‘head-direction’ neuron

Head direction cell orients the head relative to the world, not just the trunk of the body.

The mind has a map of the room from 0 to 360 degree. There are certain degrees that will cause certain neurons to fire action potentials and remain silent for others.