

## Sense of Hearing-Review

- Outer and middle ear channel sound waves to inner ear and amplify energy
- Inner ear cochlear duct vibrates
- Hair cells on basilar membrane move relative to stationary tectorial membrane
- Change ion permeability and membrane potential

## Vestibular System Overview

- For angular and linear acceleration of head
- Signal trigger head and eye movement to provide the retina with a stable visual image
- Make adjustment in posture to maintain balance
- Static and dynamic equilibrium

## Utricle and Sacculle (Fig 16.22)

- Macula
  - When head upright
  - Utricle patch normally horizontal
  - Sacculle patch normally vertical
- Hair cells with hair bundle (kinocilium & stereocilia)
- Overlying otolith membrane with otoliths “stones”

## Sound localization

- Relative intensity in two ears
- Arrival Time
- Humans can distinguish sources separated by as small as 1° angle

## Inner Ear (Fig 16.19)

- Temporal bone around inner ear
- Cochlea (hearing)
- Vestibular system
  - 3 semicircular canals and ducts (angular or circular acceleration)
  - 2 sac-like otolith organs (sacculle, utricle) for linear acceleration
- Surrounded by perilymph, filled with endolymph like cochlear duct

## Linear forces

- Linear acceleration or deceleration
  - Otolith lags behind due to gravity
  - Hair cells pushed back or forward
  - Depolarize or hyperpolarize
  - Neurotransmitter
  - Axons of vestibular nerve fibers repond
- Moving up or down has same effect on hair cells in vertical plane - shearing

## Semicircular Canals (Fig 16.3)

- Delicate hollow tubes with endolymph
- Oriented perpendicular to one another
- Ampulla at base
- Hair cells in crista
- Overlying cupula

### Constant rotation

- Endolymph “catches up”
- Hair cells not bent
- Stop—fluid still moving as canal stops
- Stimulate hair cells
- Detect change in rate of motion (acceleration, not velocity)
- Hair cells within one canal, orient the same

### Motion Sickness (space travel)

- Multi-modal input for balance and orientation
- Mismatch of sensory information from different sources
- Vestibular damage can be compensated

## Angular acceleration/deceleration

- Rotation in a particular plane
- Fluid lags behind (greater inertia)
- Shearing force on hair cells
- Receptor potential (depolarize or hyperpolarize)
- Neurotransmitter
- Action potentials in axons of vestibular fibers

### Equilibrium pathway

- Vestibular nerve fibers
- Input to medulla in brain stem
- Or to cerebellum
- Collaterals from medulla to cerebellum, or to thalamus and cerebral cortex
- Eye and somatic receptor input to medulla
- Medulla coordinates input to eye muscles and reflex contraction of neck, etc.

### Vestibular disorders -vertigo and nausea

- Ménière’s disease: increase in endolymph pressure- treat with diuretics
- Benign positional vertigo: (dislodged otoliths, floating in semicircular canals) occurring when shift position suddenly