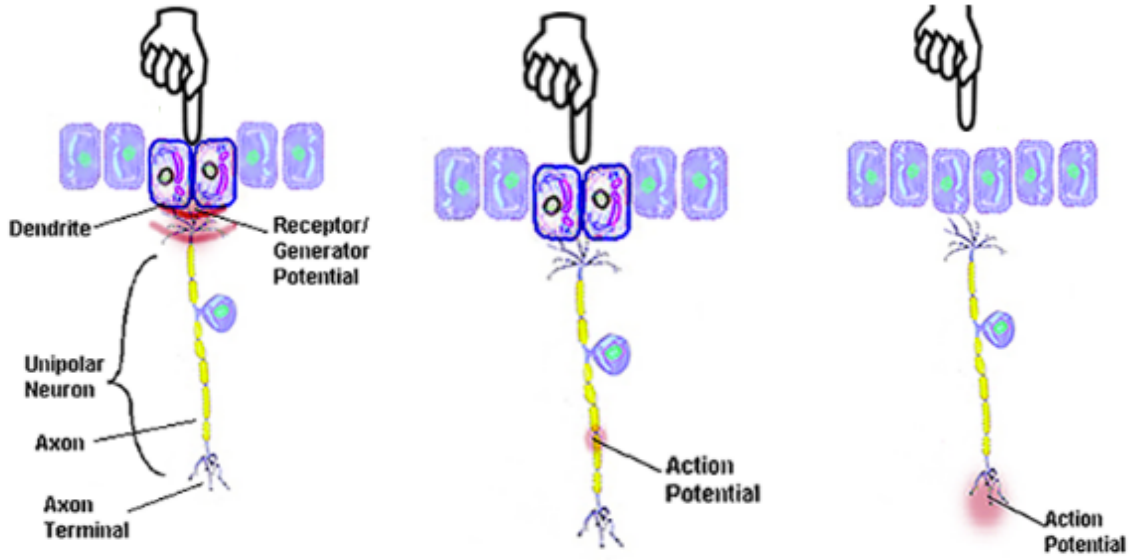
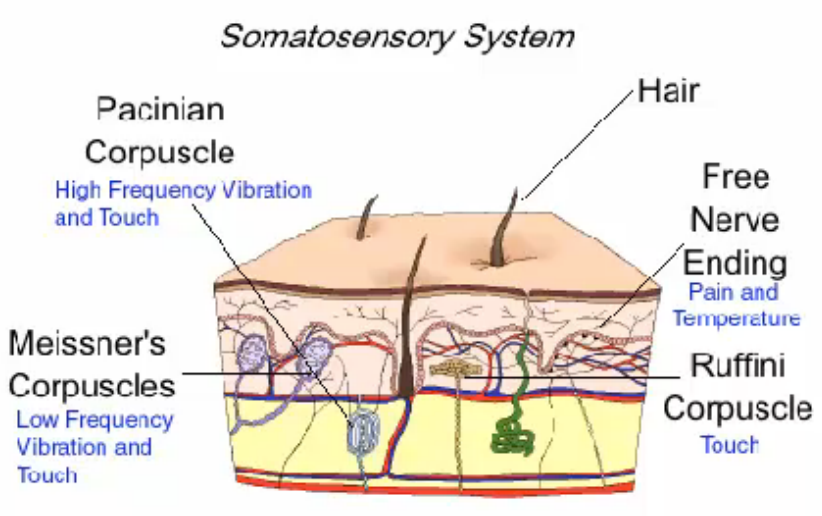
Module 7: Sensory System

- Define a sensory receptor and its adequate stimulus
    - **Adequate stimulus** is the particular form of **environmental stimulus** to which the sensory receptor is most sensitive to (cold receptors for cold things).
    - **Receptor/generator potentials** is the local depolarization of a sensory receptor that doesn't have voltage gated ion channels. It spreads to an area on the neuron where there are voltage gated ion channels (first node of ranvier on axon) to spread the synapse
    - **Transduction of outside environmental energy that eventually reaches the brain involves A SENSOR, GENERATOR PORTENTIALS, ACTION POTENTIALS, & AN ADEQUATE STIMULUS**

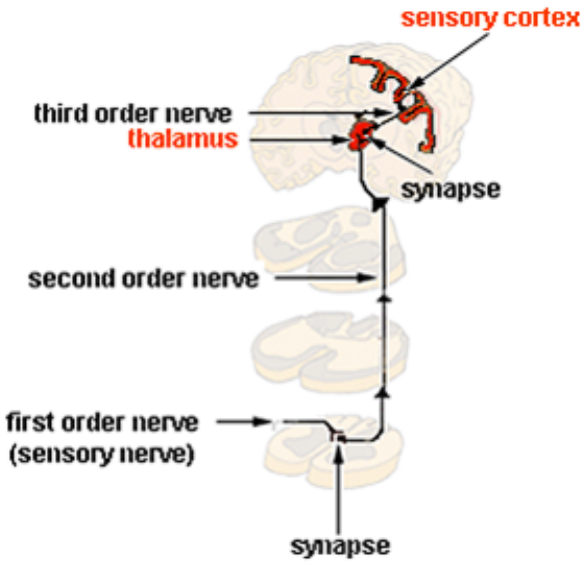


- **List 4 characteristics of generator potentials**
    1. They are generally **depolarizing but can be hyperpolarizing** as well
    2. They are caused by an **increase in permeability** to Na+ (if depolarizing) or K+ (if hyperpolarizing)
    3. They are **local** and do not propagate down the neuron like an AP but spread like an EPSP, **decreasing with time and distance** from the stimulus
    4. They are **proportional to the strength of the stimulus**—the stronger the stimulus, the larger the receptor potential and the more likely to fire and AP

- List the receptors responsible for touch, vibration, temperature, pain, and proprioception
  - **FINE TOUCH & VIBRATION→** hair follicles
  - **PAIN & TEMP→** free nerve endings
  - **TOUCH→** Ruffini Corpuscles, Merkel's disks, Meissner's Corpuscles, Pacinian Corpuscles
  - **LOW FREQ. VIBRATIONS →** Meissner's Corpuscle
  - **HIGH FREQ. VIBRATIONS→** Pacinian Corpuscle



- Define receptive field of a neuron. Name 2 major ascending sensory pathways and describe their anatomy and the info they carry
  - **Receptive field** is the area on the surface of the skin where an adequate stimulus will activate a particular receptor to fire an AP in the neuron
  - **SPINOTHALAMIC (Anterolateral) TRACT:** pain, temp, crude touch
    - Info→ 1st order neuron (sensory)→spinal cord→ *immediately* synapse with 2nd order neuron→DECUSSATE IN SPINAL CORD→contralateral thalamus relay station→synapse with 3rd order neuron→somatosensory cortex



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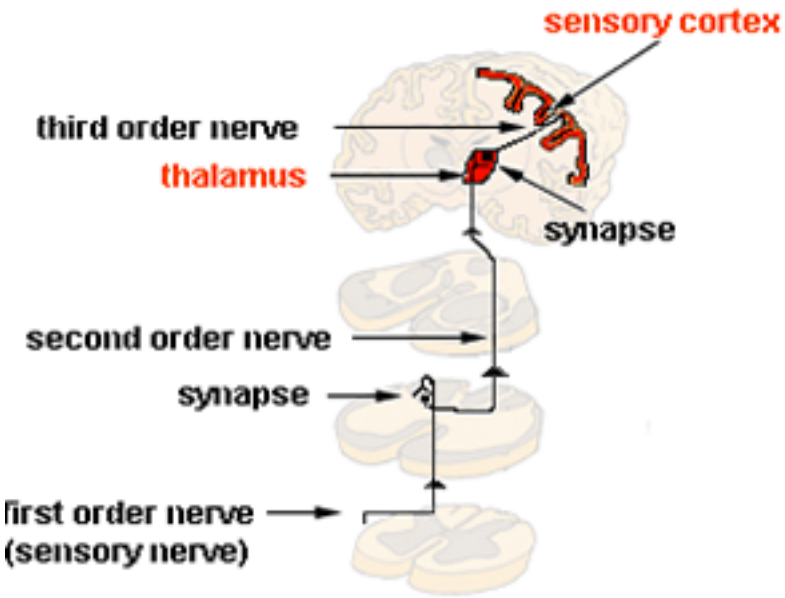
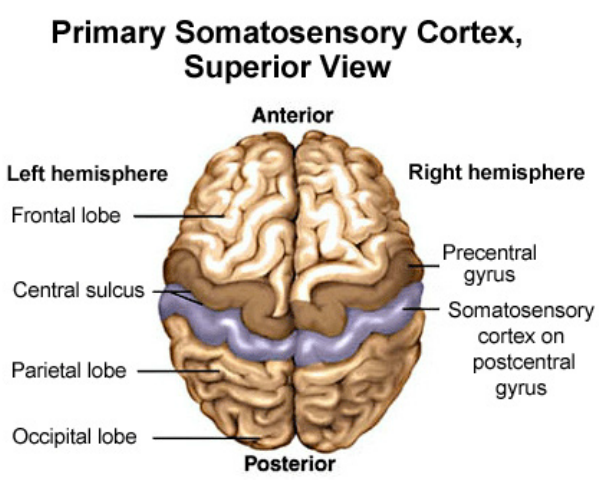
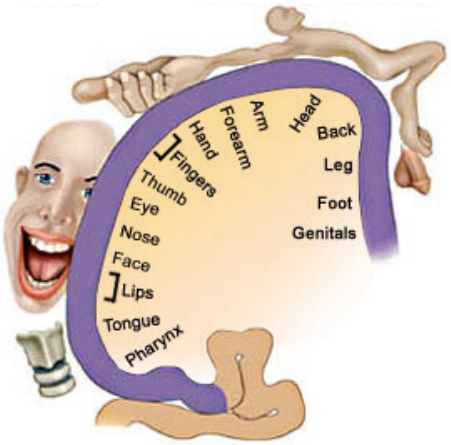
  - **MEDIAL LEMNISCAL PATHWAY (dorsal):** fine touch, proprioception, vibration

- Info→1st order neuron (sensory)→up the spinal cord→synapse with 2nd order neuron→ DECUSSATE IN SPINAL CORD→contralateral thalamus→ synapse with 3rd order neuron→somatosensory cortex



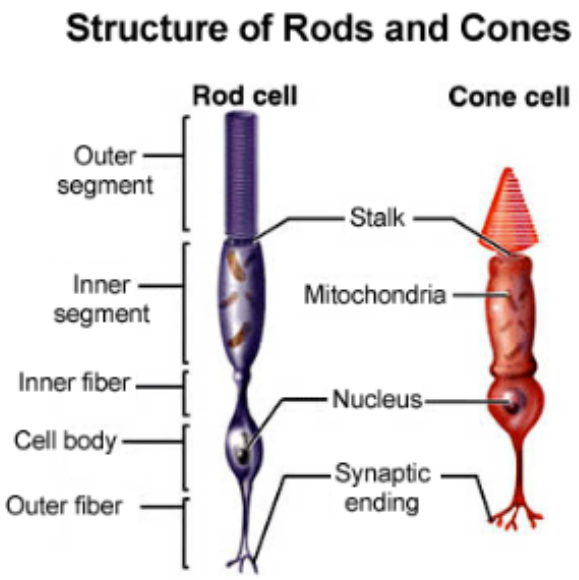
- List the somatotopic organization on the postcentral gyrus, going from medial to lateral on the cortex

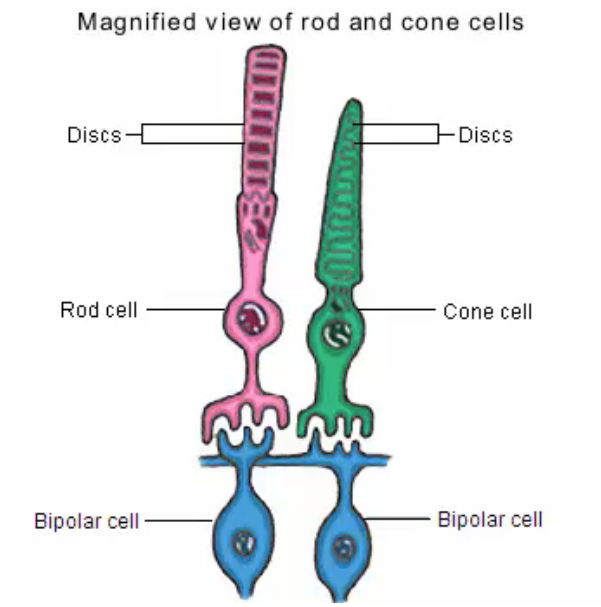




  - **Somatosensory homunculus (M→L):** genitals, foot, leg, back, head, arm, hand, fingers, eye, nose, face, lips, tongue, pharynx
- **The Visual System:** includes the eye (photoreceptors), visual pathway (transmits AP), and the primary visual area in the occipital lobe (processes incoming signals)
  - After passing through the cornea, the *amount of light* is regulated by the **iris** (constricts in bright light, dilates in low light).
  - The **lens** flips the light upsidedown/backwards and focuses it on the **retina** at the back of the eye
  - The **retina** has ***photoreceptors*** called rods and cones
    - Contains pigment layer at the back of the eye that absorbs excess light
    - Other cells include bipolar cells, ganglion cells, horizontal cells, and amacrine cells (integrate info from rods/cones, produce APs)

- List the cell types in the retina and draw a diagram of their anatomical arrangement

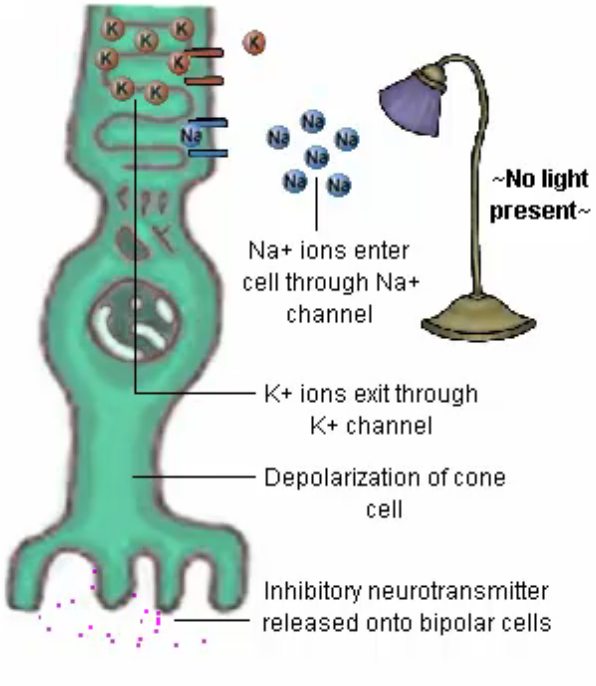


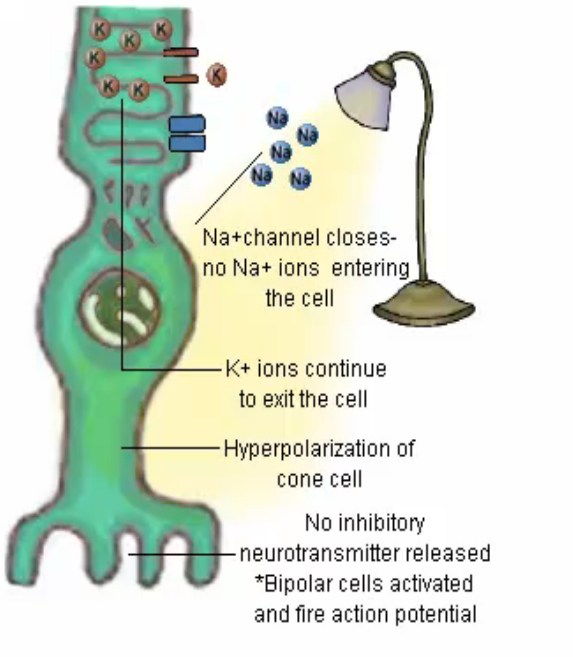


Rods- best for low light, doesn't detect color. Located in the region of the retina outside and around the fovea
Cones- best for bright light, detects detail and 3 primary colors. Located in the region of the fovea where there are found in large concentrations

Both don't have axons, so they don't generate APs. They generate receptor potentials the release an **inhibitory neurotransmitter in the DARK**

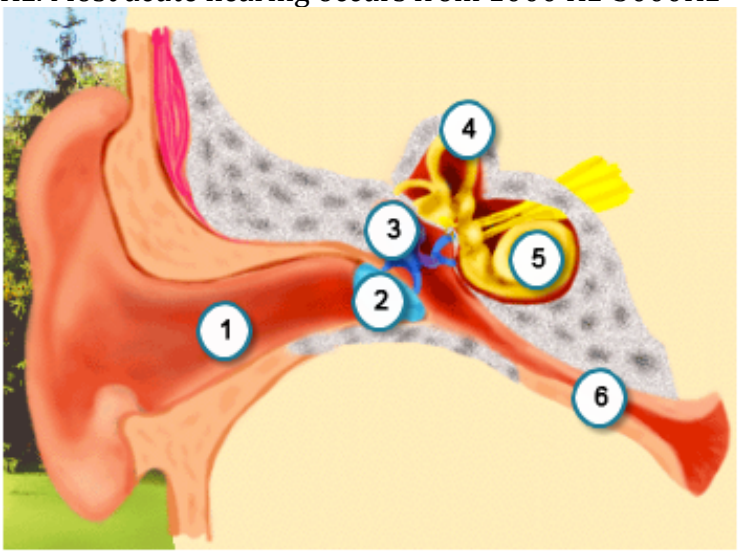
- Depolarized rods/cones hyperpolarize the sensory (bipolar cells) neuron so **no APs occur in the dark**
- ***rods/cones hyperpolarize in the light*** so that sensory neurons (bipolar cells) can depolarize, leading to an AP in the ganglion cells



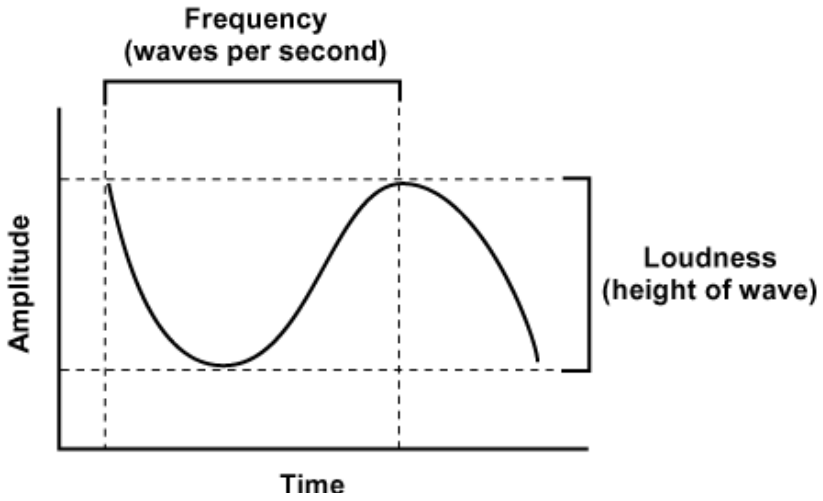


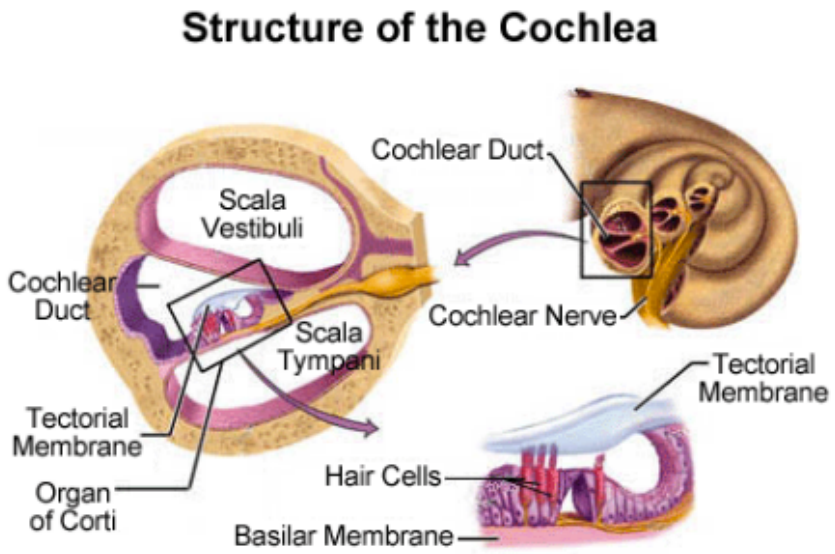
- **How light is converted into APs**
    1. Light causes photopigment in the rods/cones to change shape
    2. Decrease in Na+ permeability of rod/cone by closing Na+ channels
    3. Cell hyperpolarizes (less Na+ in and K+ leak out)
    4. Hyperpolarization decreases release of inhibitory NT
    5. Bipolar cells now activated, activating ganglion cells toward the visual cortex

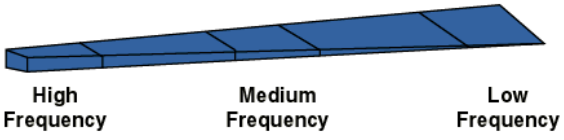
- List 4 types of eye movements, describe when they occur, and describe their overall function
    1. **Saccades-** rapid jerky movements like reading words on computer or looking around the room
    2. **Smooth pursuit**- smooth movement to keep a moving object of interest focused on the fovea, like when following the flight of a bird
    3. **Vestibular Ocular Reflex (VOR)**- eye movement made when you focus on an object while moving head back and forth, shaking it, or up and down (nodding/shaking head at someone)
    4. **Vergences**- eye movement made when object is approaching (eyes converge) or moving away (eyes diverge) from you

- **AUDITORY SYSTEM-** converts sound waves from external environment into APs that travel to the auditory system of the brain. Healthy human ear can detect sounds from 20 Hz – 20 000 Hz. Most acute hearing occurs from 1000 Hz-3000Hz
- 

    - the **<u>OUTER EAR</u>** contains the ear/auricle and the **1) external auditory canal**
    - the **<u>MIDDLE EAR</u>** contains the **2)eardrum (tympanic membrane), 3) ear ossicles (malleus, incus, and stapes),** and the **6) Eustachian Tube**
    - the **<u>INNER EAR</u>** contains the **4) vestibular apparatus (sense of balance),** and the **5) cochlea (processes sound)**

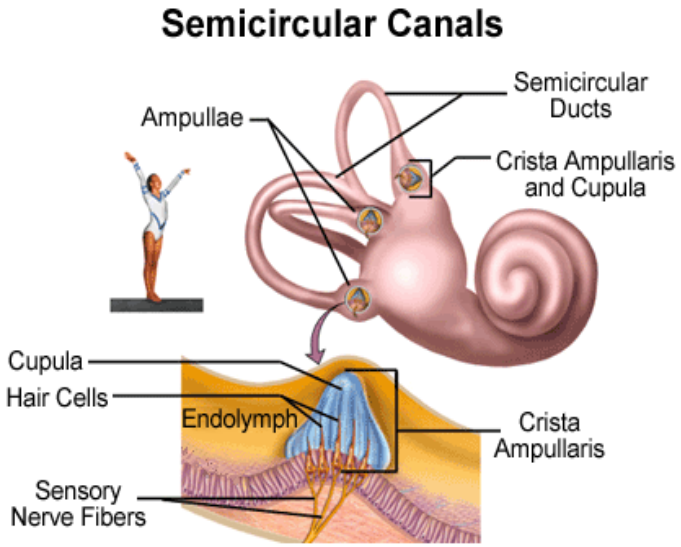


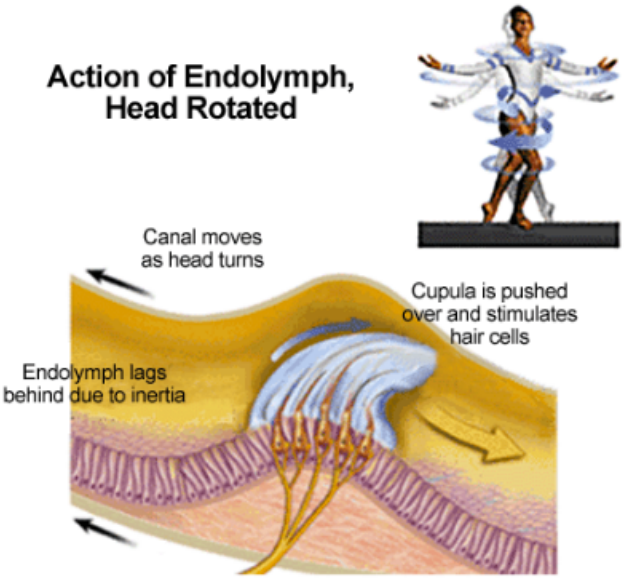


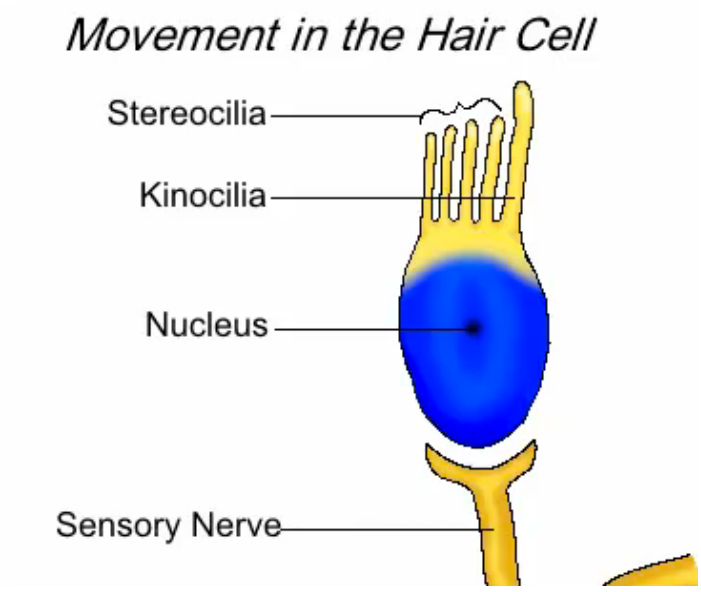
- 3 ways in which the outer and mid ear act to transmit pressure waves from air to fluid
  - Airwaves funneled into the external auditory canal to strike the tympanic membrane, causing it to flex back and forth
  - Levering action of ear ossicles amplifies the pressure waves that strike the tympanic membrane
  - Ear ossicles amplify vibrations to the oval window, (15-20x) → fluid inside the cochlea (perilymph) transmits the waves to hair cells embedded in the basilar membrane, detecting vibrations and turns them into APs in the auditory nerve. Sound is dampened at the round window
  - Pressure waves in the fluid created by the vibrations of the oval window produce a travelling wave on the basement membrane, reaching a peak at different regions of the membrane (HIGH PITCH-> near base; LOW PITCH -> top of cochlea)
  - **Basilar membrane** is wide/thin at the top of the cochlea and narrow/thick at the base near the oval window. Only certain hair cells will be activated by certain sounds. Length and stiffness of hair cells also differ.
  - 

- Describe how different frequencies of sound are transduced into action potentials
    - Basilar membrane vibrates → hair cells bent → ion channels open → cells depolarize → neurotransmitter released from hair cells → auditory nerve neurons fire AP
        - The louder the sounds, the stronger the vibration, the more bent hair cells, the more NT released, higher frequency produced, more APs produced
- List major functions served by the vestibular system
    - Maintains balance, equilibrium and postural reflexes by detecting linear and rotational motion and the position of your head relative to the rest of the body
- Name the movement detected by the semicircular canal receptors and the two detected by the otolith organs

    - **Semicircular canals** detect *rotational/angular accelerations of the head.* (3 SC canals for each plane of motion). Filled with endolymph. When head rotates to left → endolymph "lags" moving to the right → hits cupula → bends hair cells embedded in it → AP fired sending signals to brain
        - If bent in the opposite direction, it will hyperpolarize, sending no signals to brain







At rest, small resting level of NT released onto sensory nerve, firing APs

When the smaller stereocilia bend **toward** the larger kinocilium (ACCELERATION), hair cells release *more* NT → *more* AP

When smaller stereocilia bend **away** from the larger kinocilia (DECELERATION), hair cells release *less* NT → *less* AP

- **Otolith organs** detect *linear accelerations* (<u>Saccule for vertical plane and Utricle for horizontal plane</u>). Hair cells are anchored at the base, embedded in a gelatinous membrane that has otolith crystals to give it weight and inertia during movements.
    - During **<u>acceleration</u>**, otolith crystals "lag" to opposite direction → cilia of hair cells bend to opposite direction → increase freq. of AP in vestibular nerve
    - At **<u>constant velocity/rest</u>**, hair cells return to "resting state", low freq. APs
    - During **<u>deceleration</u>,** hair cells bend in other direction → freq. of AP decrease even more than resting state