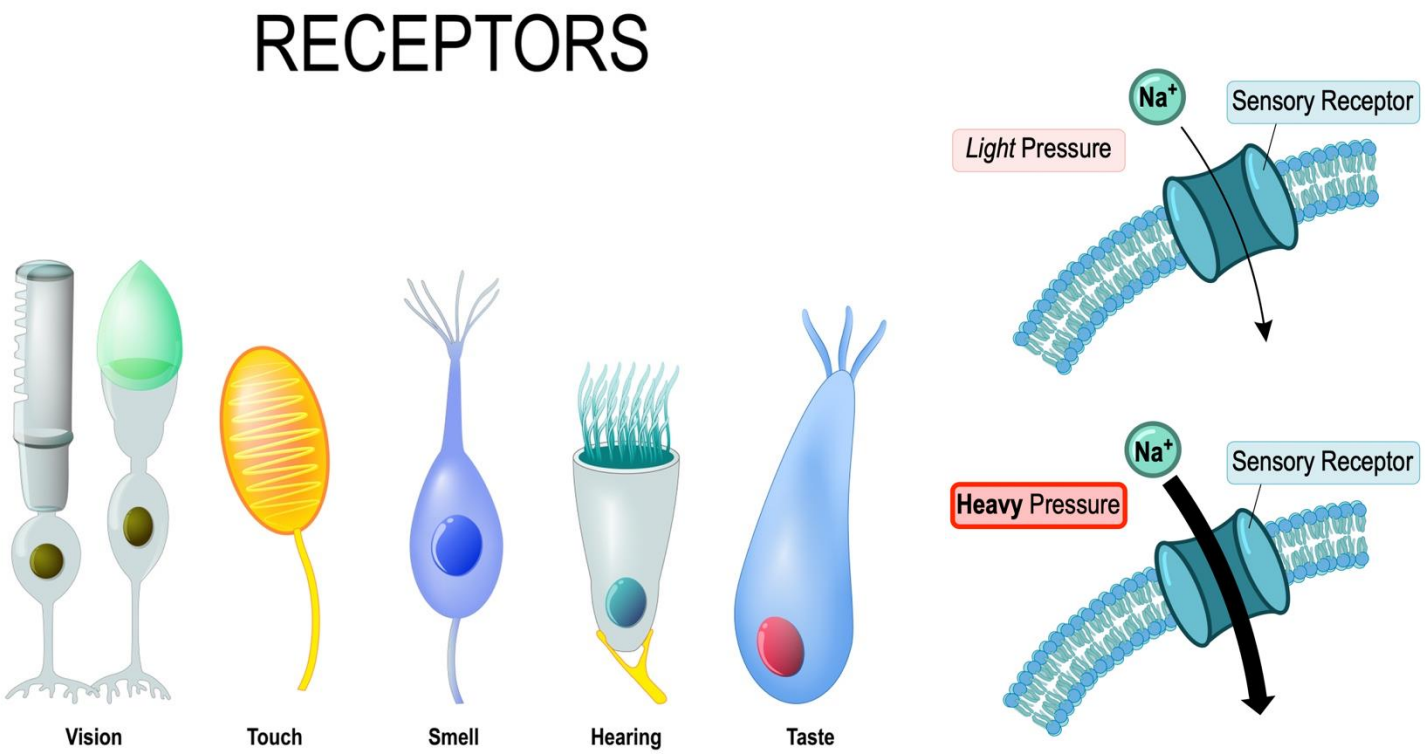
CONCEPT: SENSORY SYSTEM

- ***Sensory systems*** are the part of the nervous system that receives and processes sensory information
- ***Sensory reception*** – detection of stimulus by sensory receptors
    - ***Sensory receptor*** – nerve that responds to stimuli, transducing a response with graded or action potentials
        - Sensory receptors only respond to specific stimuli
- ***Sensory transduction*** – conversion of external stimulus to internal signal in the form of graded or action potentials
    - Signals may be greatly amplified during transduction
- ***Receptor potential*** – graded potential generated by activation of sensory receptors
    - Graded potential will depolarize, or hyperpolarize the membrane potential
    - Receptor potentials are transduced into APs, magnitude of receptor potential = frequency of APs
- ***Sensory adaptation*** – change over time of a sensory response to a stimulus

EXAMPLE:

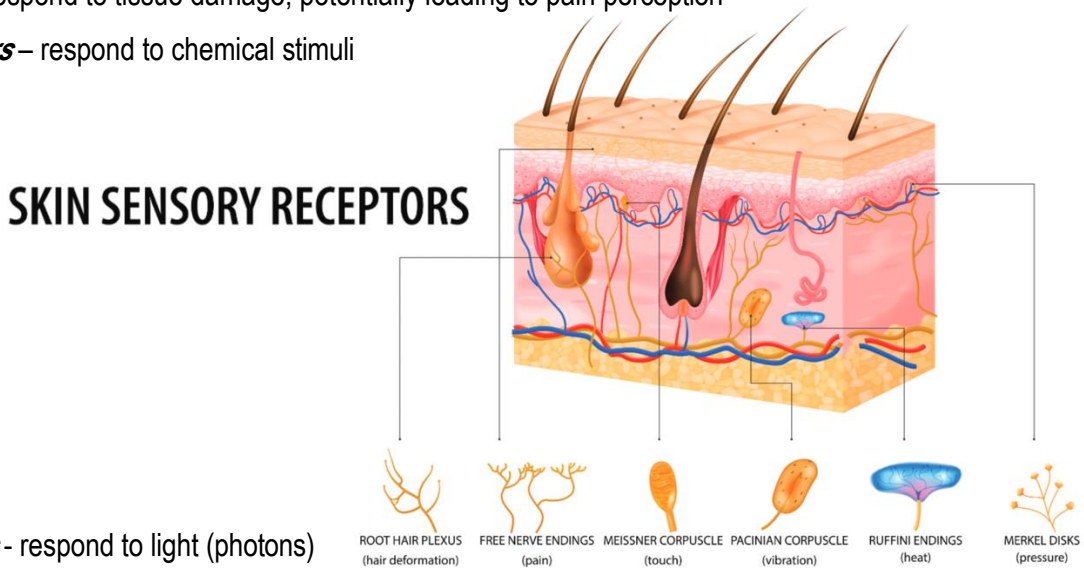


- ***Transmission*** – sensory information is transmitted to the CNS
    - Sensory neurons carry information to specific parts of the brain due to localization of function
- ***Perception*** – sensory information is processed by the brain into meaningful representations of the stimuli

CONCEPT: SENSORY SYSTEM

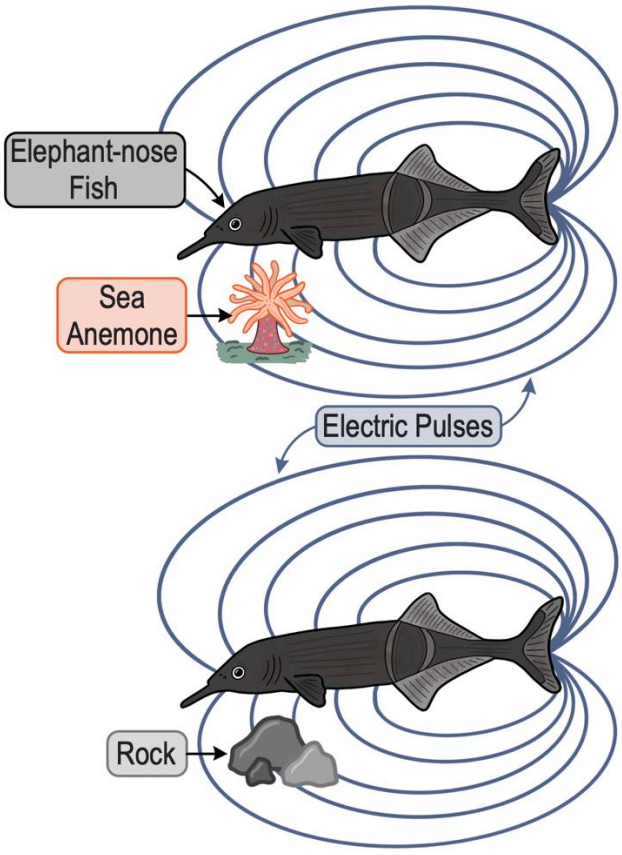
- ***Mechanoreceptors*** – respond to pressure and physical distortion
- ***Thermoreceptors*** – respond to changes in temperature
- Proprioceptors – respond to position and movement in skeletal muscles and joints
- ***Nociceptors*** – respond to tissue damage, potentially leading to pain perception
- ***Chemoreceptors*** – respond to chemical stimuli

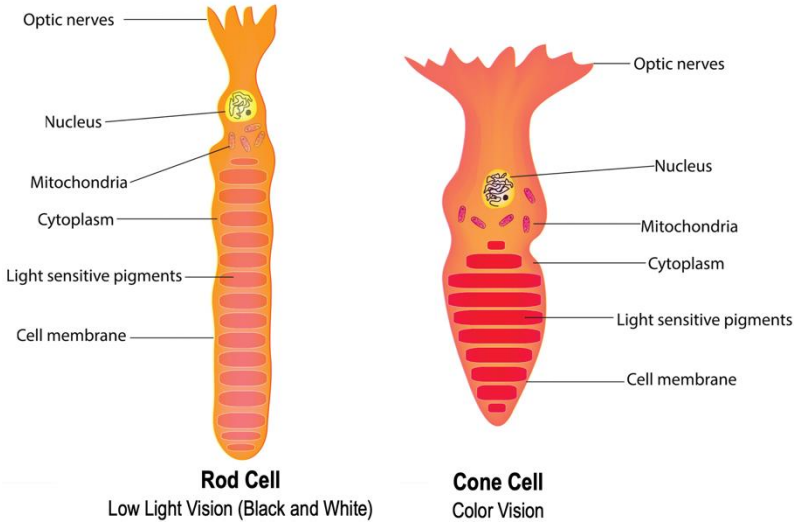
EXAMPLE:



- ***Photoreceptors*** - respond to light (photons)
- ***Electroreceptors*** – respond to electric fields
- ***Magnetoreceptors*** – respond to magnetic fields

EXAMPLE:

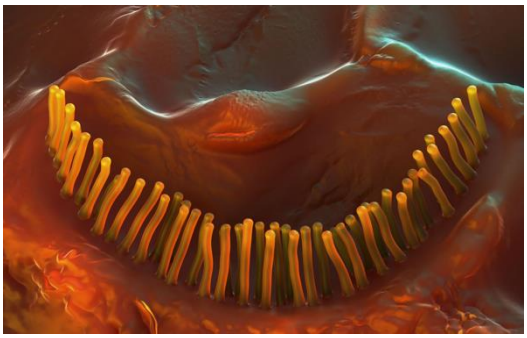


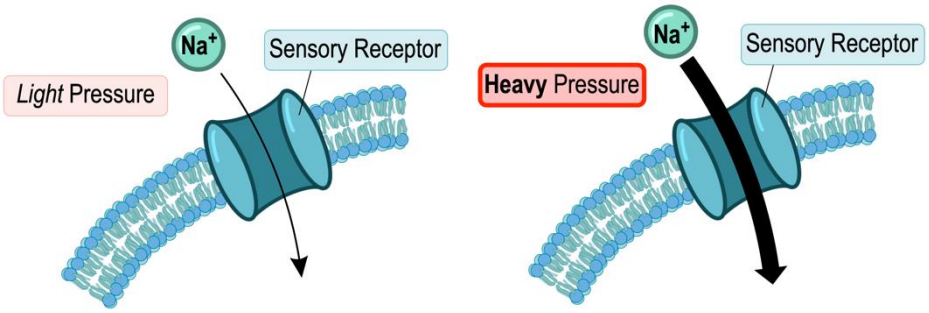


CONCEPT: SENSORY SYSTEM

- ***Hair cells*** – sensory receptors of auditory and vestibular systems that use physical stimulation to open ion channels
    - ***Stereocilia*** – projections on hair cells that can be physically manipulated to change membrane potentials
        - Bending opens ion channels creating a graded potential to transduce the stimulus

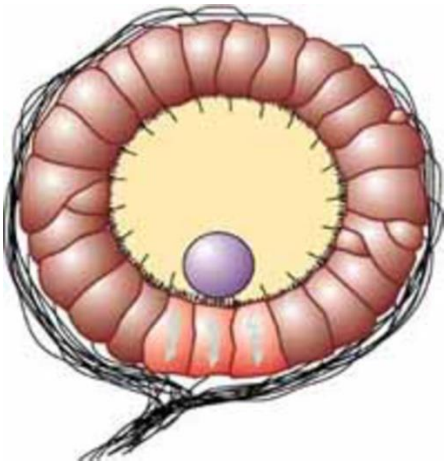
EXAMPLE:

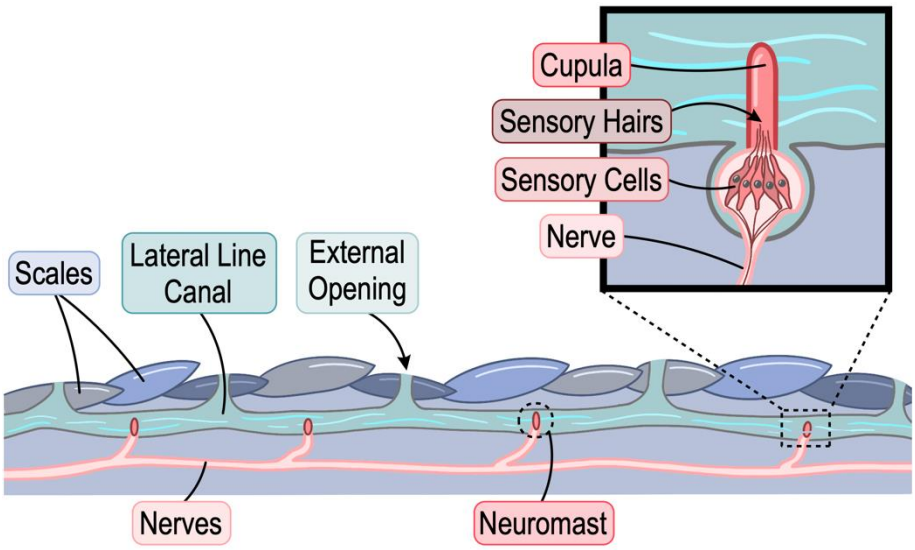




- ***Statocysts*** – balance sensory receptor that uses gravity to stimulate hair cells in sac-like structure
    - ***Statoliths*** – mineral crystals that touch the hair cells to stimulate them
- ***Lateral line system*** – uses hair cells allowing fish and amphibians to detect movement in water

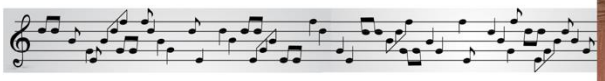
EXAMPLE:





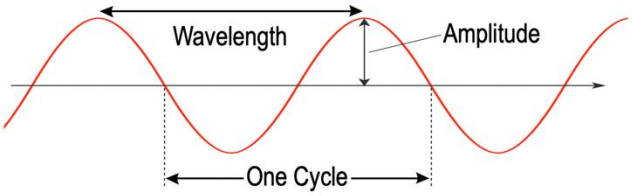
CONCEPT: SENSORY SYSTEM

- ***Hearing*** – perception from ear transducing physical stimulus of pressure waves in the air
    - ***Sound*** – vibration that propagates pressure waves through air or water
        - ***Frequency*** – cycles per second of the wave
        - ***Pitch*** – perception of frequency, like different notes on an instrument



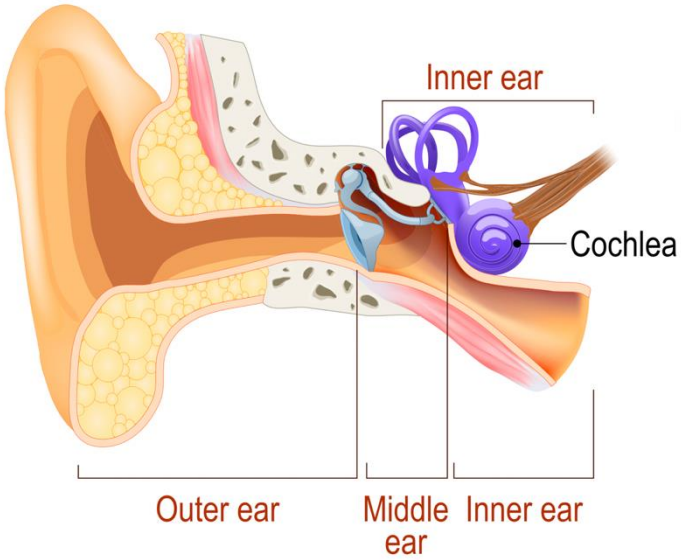
- ***Ear*** – organ of hearing and balance

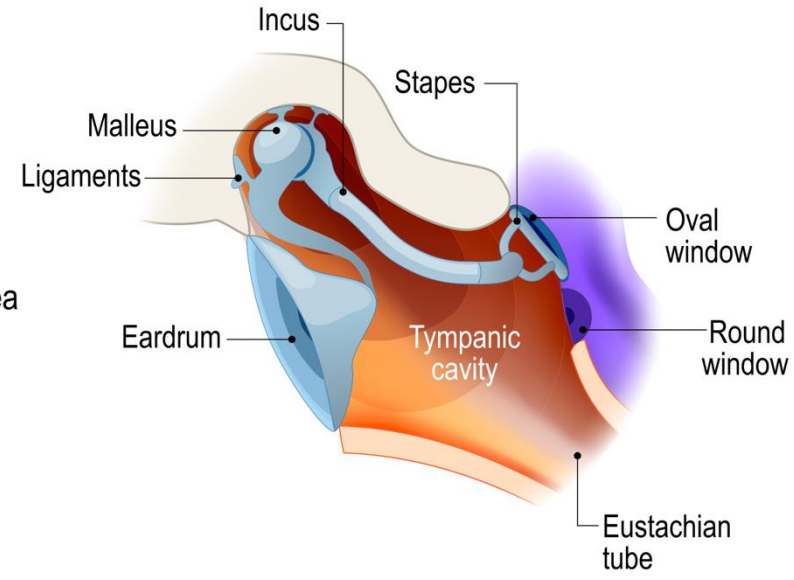
EXAMPLE:



- ***Outer ear*** – gathers and transmits sound to the tympanic membrane
    - Tympanic membrane – ear drum, thin membrane that separates outer and middle ear
- ***Middle ear*** – contains bones that amplify sounds
    - ***Eustachian tube*** – connects middle ear to nasopharynx
    - ***Ossicles*** – three bones in the middle ear that amplify sound as it travels into the inner ear
        - Stapes – innermost ossicle that vibrates the oval window
    - ***Oval window*** – membrane-covered opening that leads from middle ear to inner ear

EXAMPLE:

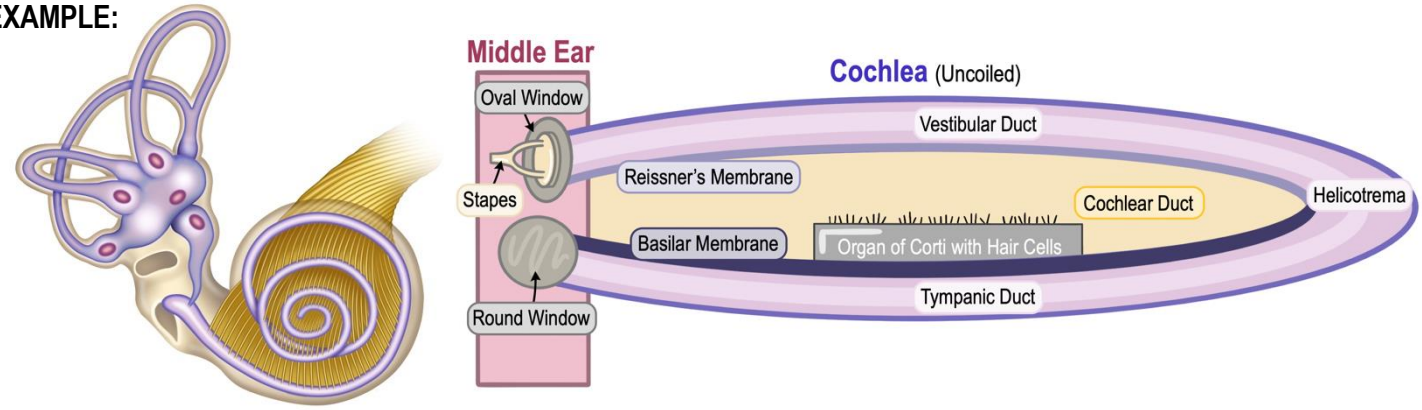




CONCEPT: SENSORY SYSTEM

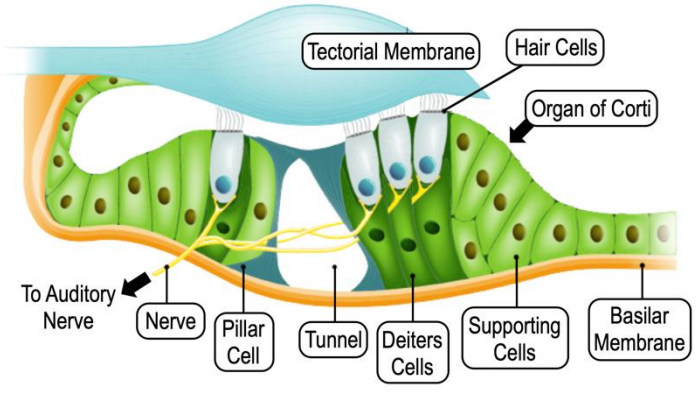
- ***Inner ear*** – contains hair cells responsible for sound detection and balance
    - ***Vestibular system*** – balance detecting system that uses the movement of fluid to stimulate hair cells
        - ***Semicircular canals*** – three fluid filled canals used to detect rotational movement
    - ***Cochlea*** – spiral-shaped cavity containing hair cells used to detect sound
        - Cochlea contains 3 fluid-filled cavities, and is shaped like a coiled up cone

EXAMPLE:



- ***Basilar membrane*** – membrane in the middle of the cochlea that sits underneath cochlear duct
    - ***Organ of Corti*** – sits on basilar membrane and contains many hair cells
    - Different regions vibrate at different frequencies of sound waves
- ***Tectorial membrane*** – located above the hair cells in the Organ of Corti
- Waves travel through fluid from the oval window, and vibrate region of basilar membrane that matches their frequency
    - Wave amplitude translates into volume of sound, frequency translates into pitch
- ***Round window*** – membrane-covered opening at end of a duct in the cochlea, dampens waves to prevent reverberation

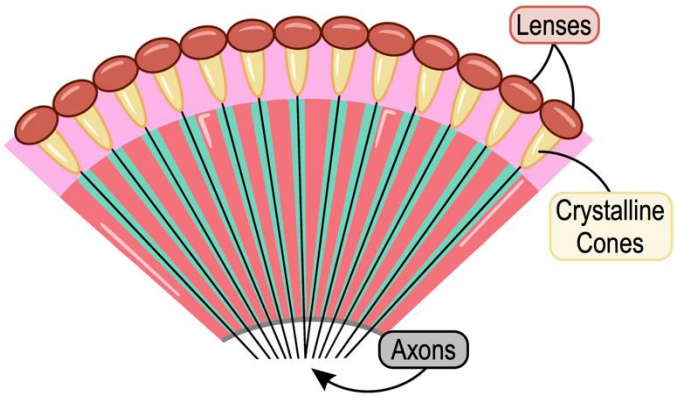
EXAMPLE:

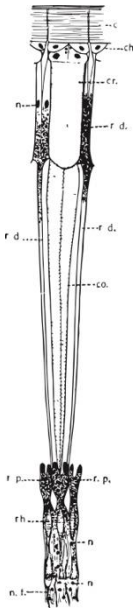


CONCEPT: SENSORY SYSTEM

- ***Photoreception*** – detection of light
- ***Compound eye*** – eye composed of many ommatidia found in arthropods
    - ***Ommatidia*** – contain a cluster of photoreceptors

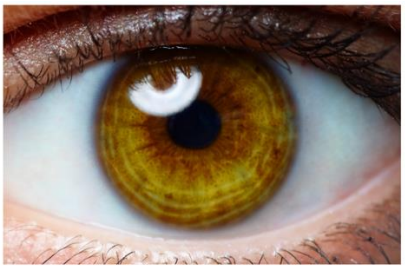
EXAMPLE:

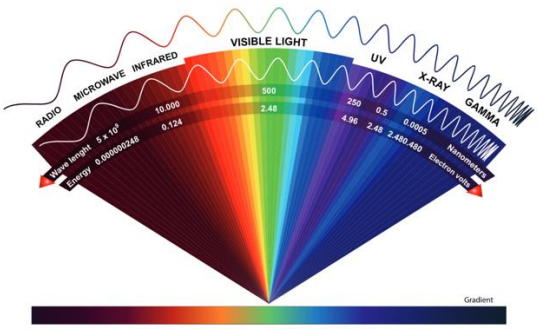


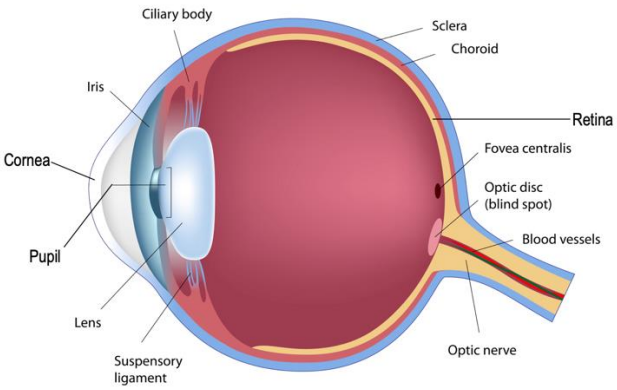


- ***Simple eye*** – single-lens eye similar to a camera
- Human eye perceives the ***visible spectrum*** of light
    - ***Sclera*** – white of the eye, protective structure composed of collagen and elastic fibers
    - ***Cornea*** – fluid-filled, transparent cover over iris and pupil, strongly refracts light
    - ***Iris*** – controls pupil diameter and lens shape
    - ***Pupil*** – hole that lets light pass through the lens
    - ***Lens*** – structure that changes shape to focus light from cornea
    - ***Retina*** – back of the eye containing photoreceptors

EXAMPLE:



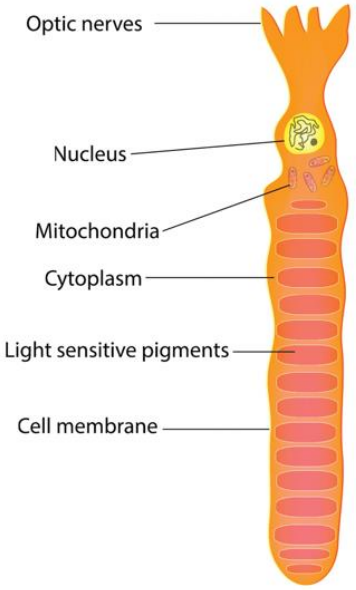


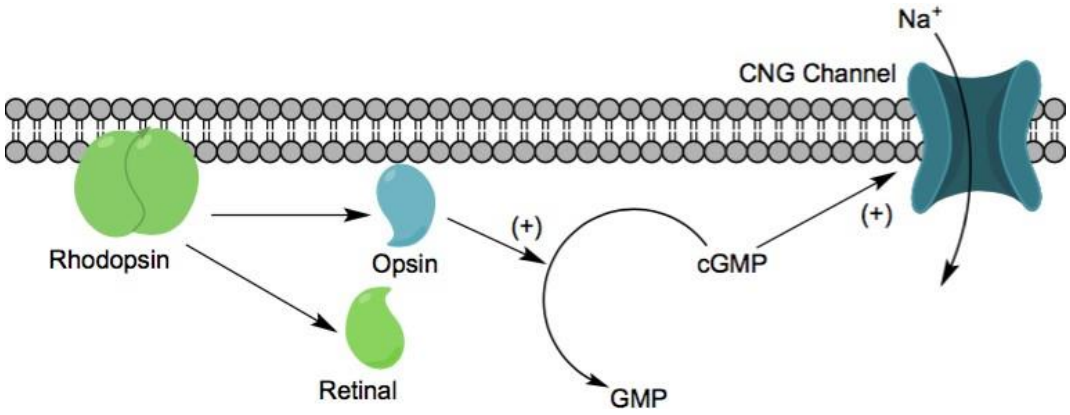


CONCEPT: SENSORY SYSTEM

- Phototransduction occurs in the photoreceptors in the retina
- ***Rods*** – photoreceptors that can detect lower levels of light, and are found around the outer edges of the retina
- ***Rhodopsin*** – light-sensitive receptor protein used in phototransduction by rods, composed of retinal and opsin
    - ***Retinal*** – light-absorbing molecule, form of vitamin A
    - ***Opsin*** – light-sensitive protein
    - When retinal absorbs light its structure is rearranged, causing conformational changes in opsin
        - Acts a G protein receptor that leads to the opening of Na^+ ion channels

EXAMPLE:

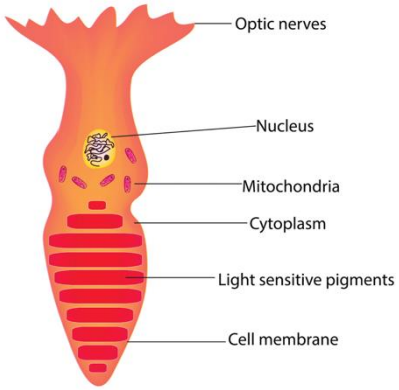




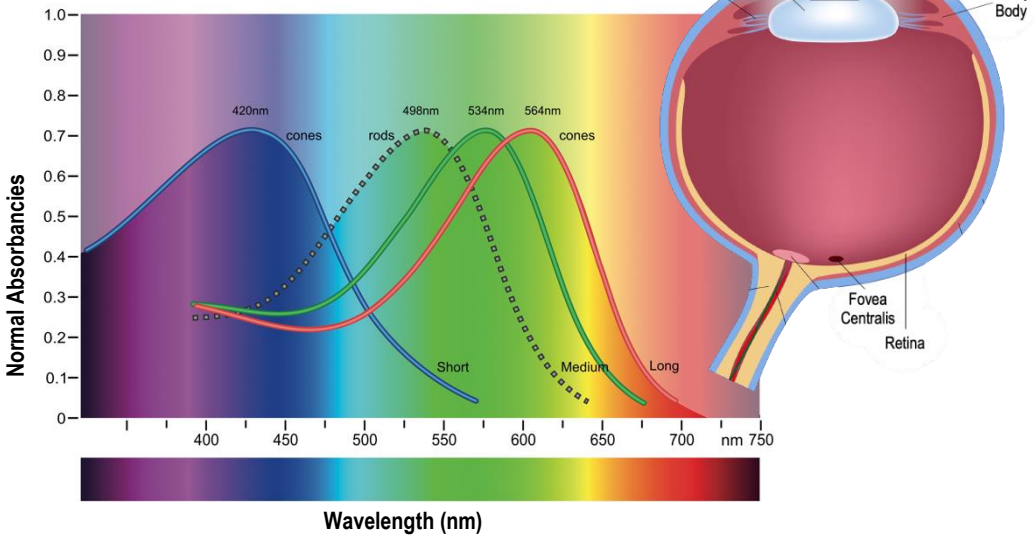
Rod Cell
Low Light Vision (Black and White)

- ***Cones*** – photoreceptors that are used for color vision, function best in bright light
    - Uses different pigments to absorb different wavelengths of light
    - ***Fovea*** – central area of retina that is densely packed with cones

EXAMPLE:



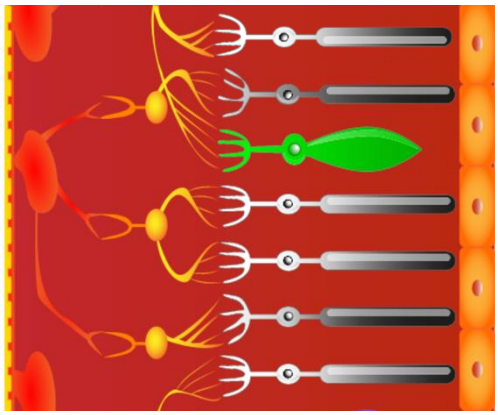
Cone Cell
Color Vision

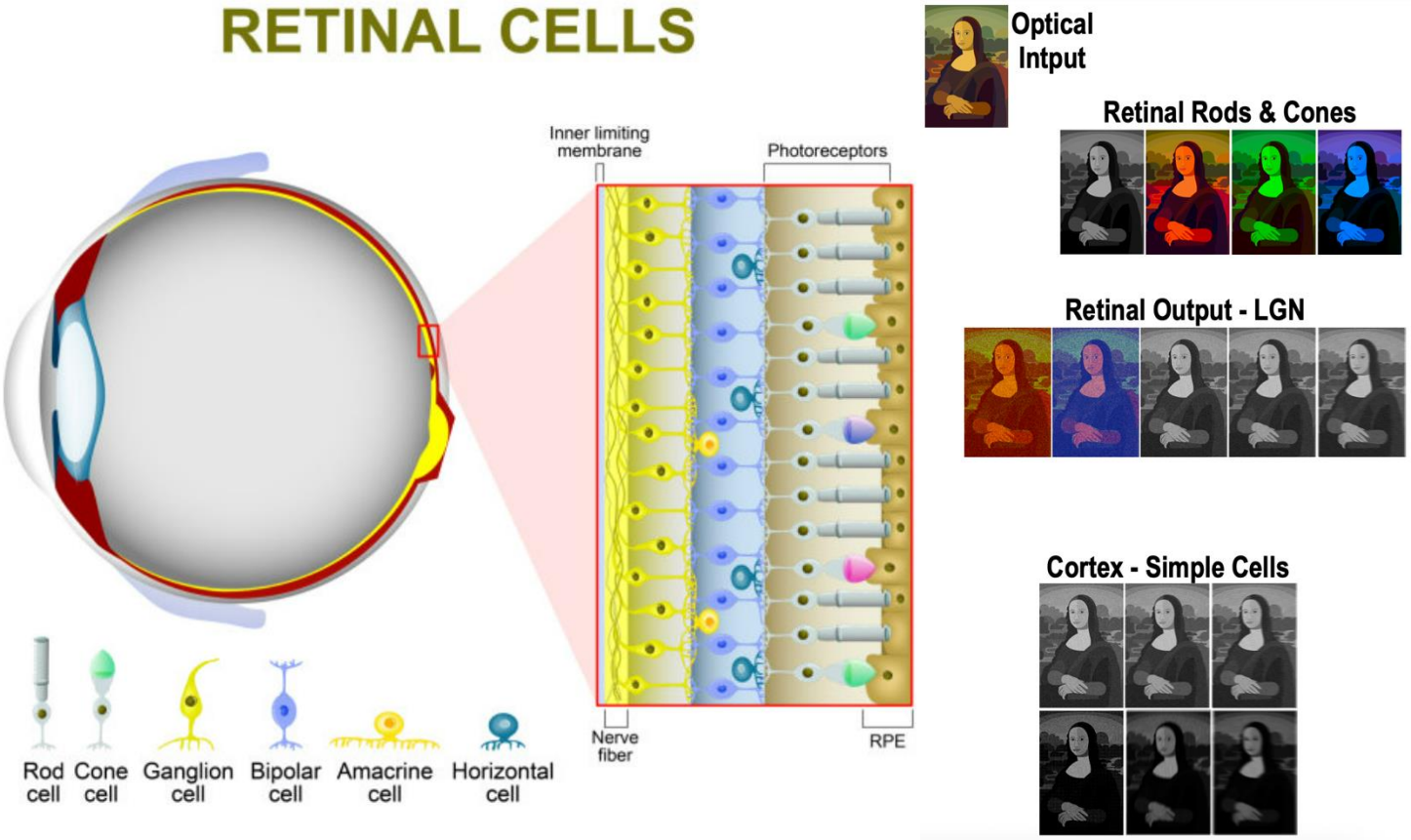


CONCEPT: SENSORY SYSTEM

- Retina is composed of ***photoreceptors***, ***bipolar cells***, and ***ganglion cells***
  - Photoreceptors ➔ bipolar cells ➔ ganglion cells
  - Receptor potential is generated by hyperpolarization from the opening of Na^+ ion channels
  - Photoreceptors and bipolar cells have graded potentials, ganglion cells have action potentials
  - Ganglion cells receive input from multiple rods and cones
- ***Optic nerve*** – composed of the axons of ganglion cells, brings information to the brain

EXAMPLE:



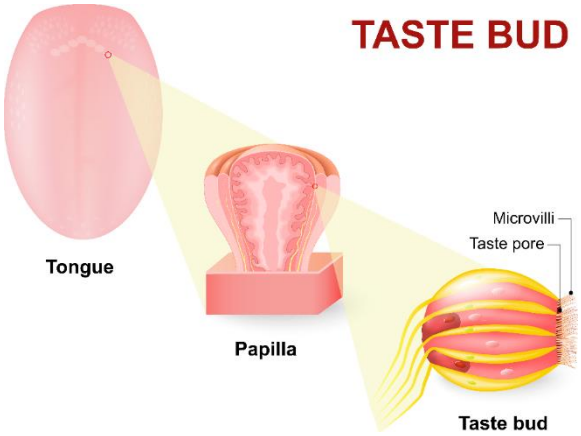


- Visual processing in the brain integrates lots of sensory information about color, edges, movement, and depth
  - Binocular vision uses input from both eyes for depth perception

CONCEPT: SENSORY SYSTEM

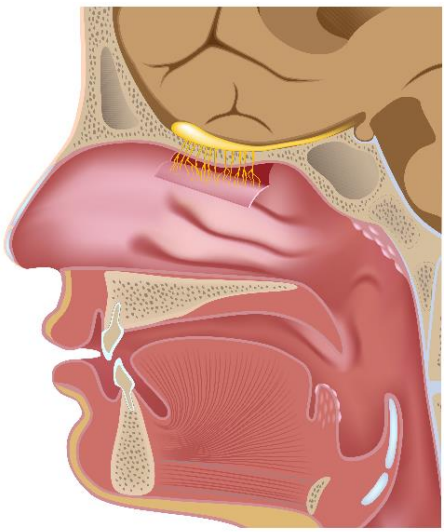
- ***Chemoreception*** – detection of chemicals
    - Chemoreceptors change membrane potential when a specific type of compound is present
- ***Gustation*** – sense of taste mediated by taste receptors
    - ***Taste receptors*** – receptors in taste buds on the tongue
- ***Tastants*** – molecules that stimulate taste receptors
    - Salt – electrolytes (Na^+)
    - Sour – acid (H^+)
    - Sweet – carbohydrates like glucose
    - Umami – proteins and amino acids like glutamate
    - Bitter – used to identify poisonous compounds
    - Salt and sour receptors have ion channels to detect their tastants

EXAMPLE:



- ***Olfaction*** – sense of smell mediated by olfactory receptors
    - ***Olfactory receptors*** – chemoreceptors that bind odorant molecules
    - ***Odorant*** – airborne molecules that are smelled
- ***Olfactory bulb*** – part of the brain where olfactory information is processed
    - ***Glomeruli*** – areas in where olfactory neurons of the same receptor type converge
- ***Pheromone*** – chemical secreted to the environment that affects behavior and physiology of individuals of same species
    - Vomeronasal organ – distinct region from olfactory bulb that contains pheromone receptors

EXAMPLE:



Olfactory Nerve