



The Human Senses

Sensory Transduction

- The fundamental process where a sensory receptor converts the energy of a stimulus (e.g., light energy, mechanical energy) into an electrical signal (a nerve impulse).



The Five Traditional Senses



- **Vision (Sight):** Detects light.
- **Audition (Hearing):** Detects sound waves.
- **Olfaction (Smell):** Detects airborne chemical molecules.
- **Gustation (Taste):** Detects dissolved chemical molecules.
- **Somatosensation (Touch):** Detects physical contact, temperature, and pain.

The Sense of Sight (Vision)



- **Stimulus:** Light (a form of electromagnetic energy).
- **Receptor Organ:** The Eye.
- **Receptors:** Photoreceptors (Rods and Cones) located in the retina.
- **The Need:** Vision provides us with detailed spatial information about the world, essential for navigation and survival.

Structure of the Eye: Outer Layers



- **Sclera:** The tough, white outer layer of the eyeball that protects the inner structures.
- **Cornea:** The transparent front part of the sclera. It acts as the eye's primary **lens**, bending (refracting) light rays as they enter the eye.

Structure of the Eye: Middle Layer (Uvea)

- **Choroid:** A layer rich in blood vessels that nourishes the retina and absorbs stray light to prevent reflection within the eye.
- **Ciliary Body:** Contains muscles that change the shape of the lens (**accommodation**).
- **Iris:** The colored part of the eye. It controls the amount of light entering the eye.

The Pupil and Lens

- **Pupil:** The black opening in the center of the iris. It is an aperture whose size is adjusted by the iris muscles.
- **Lens:** A flexible, transparent structure behind the iris. It fine-tunes the focus by changing shape to project a clear image onto the retina.



Photoreceptors: Rods

- **Function:** Highly sensitive to light and responsible for vision in low-light conditions (**night vision**).
- **Detail:** They provide shades of gray and lack the ability to distinguish fine details or colors.
- **Location:** Found mostly in the periphery (edges) of the retina.

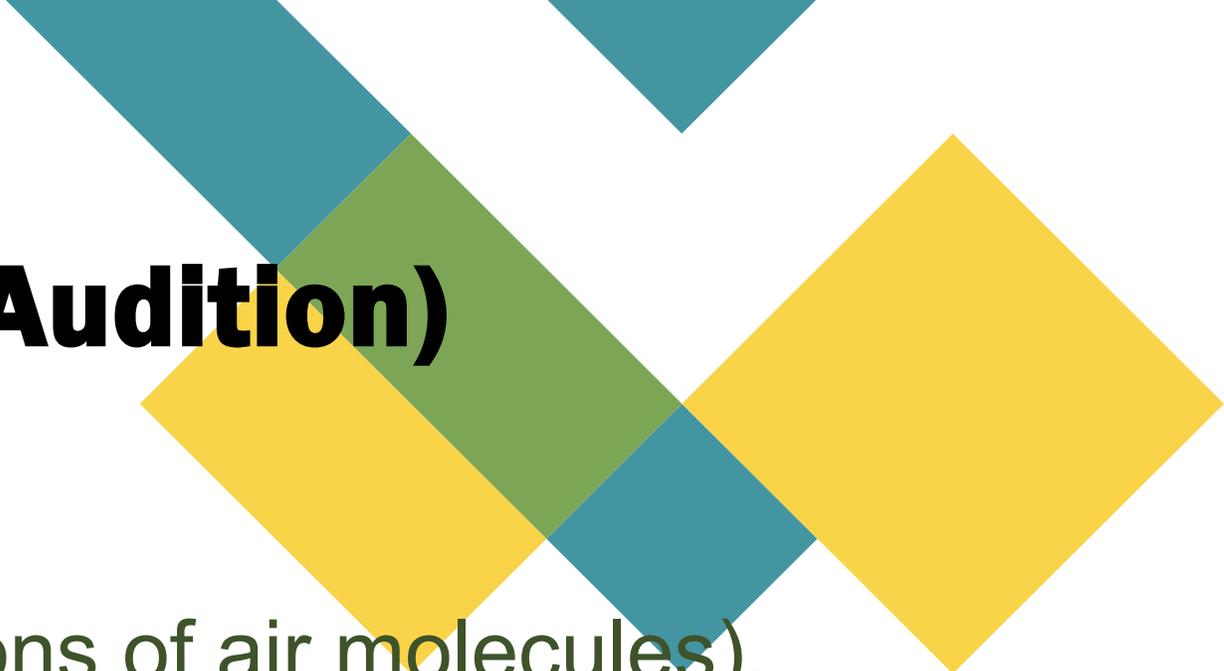
Photoreceptors: Cones

- **Function:** Require bright light to be activated and are responsible for **color vision** and high visual acuity (detail).
- **Types:** Humans have three types of cones, each sensitive to different wavelengths of light (red, green, or blue).
- **Location:** Concentrated in the fovea.

The Visual Pathway to the Brain

- **Optic Nerve:** Neural signals from the retina are gathered and sent out through the optic nerve.
- **Optic Chiasm:** A point in the brain where signals from the medial (inner) half of each eye cross over to the opposite side of the brain.
- **Visual Cortex:** The final destination for visual processing, located in the occipital lobe at the back of the brain.

The Sense of Hearing (Audition)



- **Stimulus:** Sound waves (vibrations of air molecules).
- **Receptor Organ:** The **Ear**.
- **Receptors:** Hair cells located in the **cochlea**.
- **Function:** To detect, transduce, and interpret vibrations as sound.

Structure of the Ear: Outer Ear



- **Pinna (Auricle):** The visible, external cartilage structure. It acts like a funnel, collecting sound waves.
- **External Auditory Canal:** A tube that channels sound waves towards the middle ear.
- **Tympanic Membrane (Eardrum):** A thin membrane stretched across the end of the canal; sound waves cause it to vibrate.

Structure of the Ear: Middle Ear



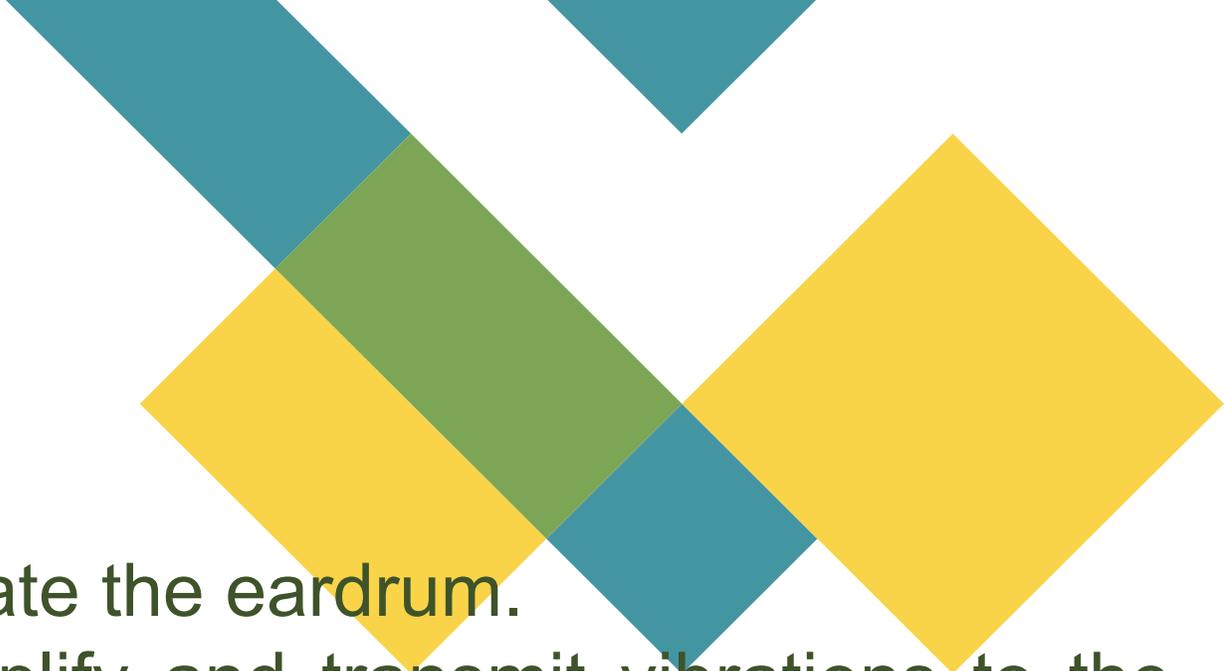
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- **Air-Filled Cavity:** A small, air-filled chamber containing the three tiny auditory ossicles (bones).
 - **Ossicles:**
 - **Malleus (Hammer):** Attached to the eardrum.
 - **Incus (Anvil):** Connects the malleus and stapes.
 - **Stapes (Stirrup):** Pushes on the oval window of the inner ear.
 - **Function:** The ossicles amplify the vibrations from the eardrum before passing them to the inner ear.

Structure of the Ear: Inner Ear



- **Bony Labyrinth:** A complex system of fluid-filled passages encased in bone.
- **Cochlea:** The spiral-shaped structure that contains the actual hearing receptors.
- **Organ of Corti:** Located within the cochlea; this is the true receptor organ, containing the sensory hair cells.
- **Function:** Converts the mechanical vibrations into electrical nerve impulses.

Mechanism of Hearing



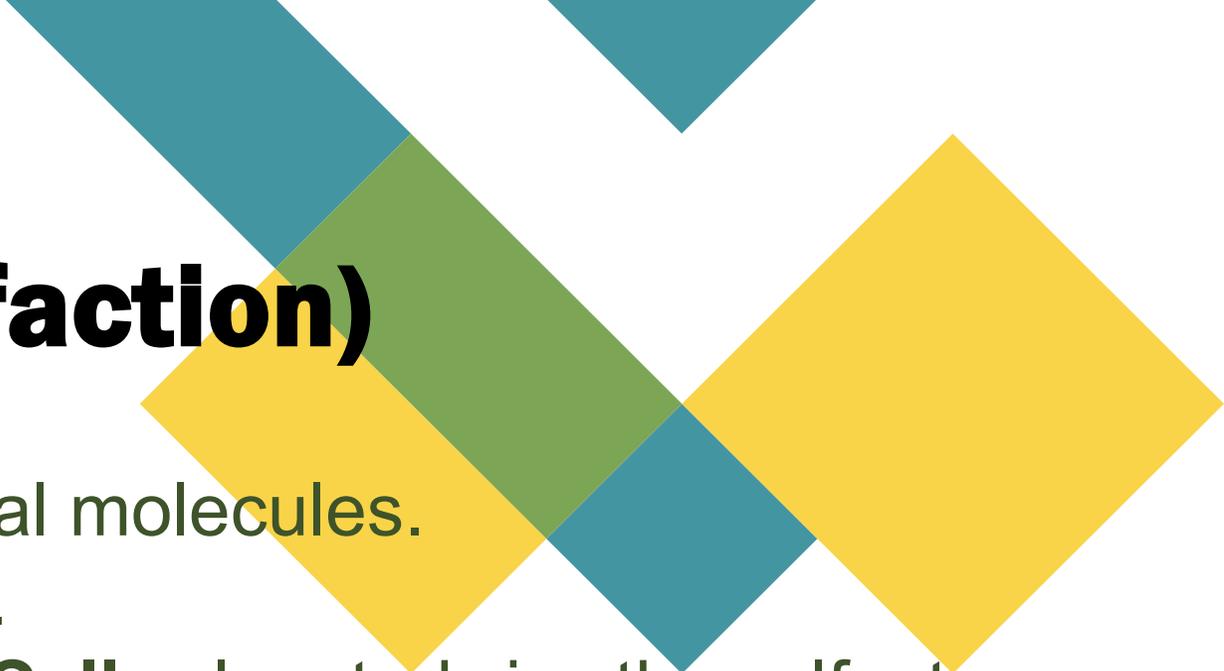
- Step 1: Vibration:** Sound waves vibrate the eardrum.
- Step 2: Amplification:** Ossicles amplify and transmit vibrations to the oval window.
- Step 3: Fluid Movement:** Vibration of the oval window creates pressure waves in the fluid inside the cochlea.
- Step 4: Transduction:** Fluid waves move the hair cells in the Organ of Corti, generating nerve impulses sent to the brain via the auditory nerve.

The Sense of Balance (Equilibrium)



- **System Location:** The sense of balance is closely integrated with the inner ear structures.
- **Two Types of Balance:**
 - **Static Equilibrium:** Position of the head relative to gravity (knowing up vs. down). Handled by the **utricle and saccule**.
 - **Dynamic Equilibrium:** Maintaining balance during rotational or linear acceleration (movement). Handled by the **semicircular canals**.

The Sense of Smell (Olfaction)



- **Stimulus:** Volatile (airborne) chemical molecules.
- **Receptor Organ:** The **Nasal Cavity**.
- **Receptors:** **Olfactory Receptor Cells** located in the olfactory epithelium at the top of the nasal cavity.
- **Pathway:** The only sense that bypasses the thalamus and goes directly to the cerebral cortex (specifically the olfactory bulb and limbic system).

Mechanism of Olfaction



- **Step 1: Inhalation:** Airborne chemical molecules are inhaled and dissolve in the mucus layer of the olfactory epithelium.
- **Step 2: Binding:** The dissolved molecules bind to specific receptors on the cilia of the olfactory receptor cells.
- **Step 3: Transduction:** This binding generates an electrical impulse.
- **Key Feature:** Humans can distinguish thousands of different odors due to the variety of receptor types and combinations.

The Link Between Smell and Memory



- **Limbic System Connection:** The olfactory pathway connects directly to the limbic system (which deals with emotion and memory).
- **Result:** Odors often trigger strong, immediate emotional memories more effectively than other sensory inputs.

The Sense of Taste (Gustation)



- **Stimulus:** Soluble chemical molecules dissolved in saliva.
- **Receptor Organ:** The Tongue.
- **Receptors:** **Gustatory Receptor Cells** located in the **taste buds**.
- **Taste Buds:** Found primarily in the papillae (small bumps) on the tongue surface.

The Five Basic Tastes

- The Tastes:
- Sweet: Detected by sugars.
- Sour: Detected by ions (acids).
- Salty: Detected by ions.
- Bitter: Detected by various complex chemicals (often associated with toxins/poison).
- Umami (Savory): Detected by glutamate (proteins).



The Interplay of Taste and Smell



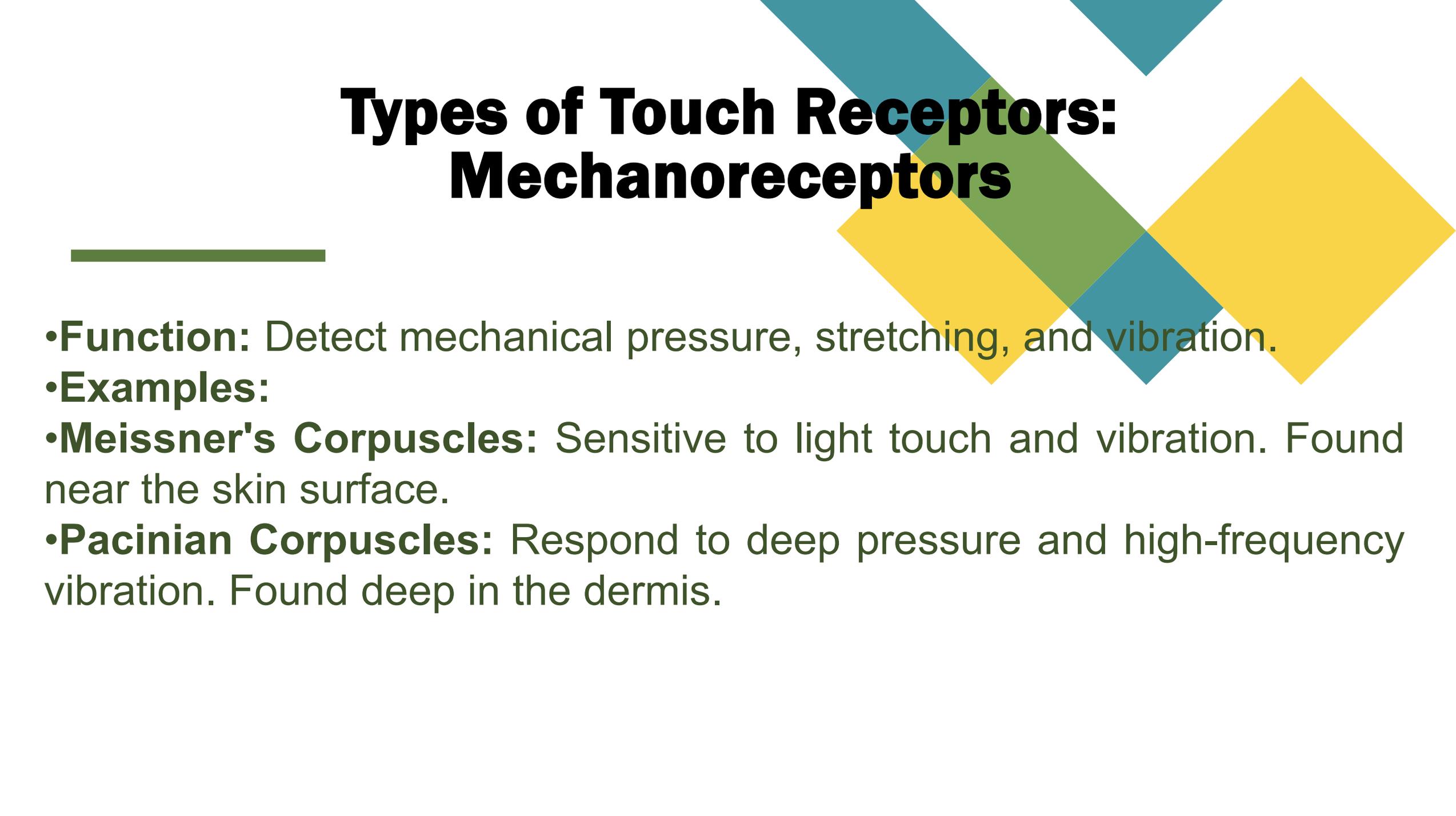
- **Flavor:** What we perceive as "flavor" is actually a complex blend of taste and smell.
- **Olfactory Dominance:** When smell is blocked (e.g., when you have a cold), our perception of flavor is severely diminished, demonstrating the dominant role of olfaction.

The Sense of Touch (Somatosensation)



- **Definition:** A collection of senses dealing with the body surface, rather than a single organ like the eye or ear.
- **Stimulus:** Mechanical pressure, vibration, heat, cold, and tissue damage.
- **Receptor Organ:** The **Skin** (the largest sensory organ).
- **Receptors:** Numerous types of sensory receptors (mechanoreceptors, thermoreceptors, nociceptors).

Types of Touch Receptors: Mechanoreceptors



- **Function:** Detect mechanical pressure, stretching, and vibration.
- **Examples:**
 - **Meissner's Corpuscles:** Sensitive to light touch and vibration. Found near the skin surface.
 - **Pacinian Corpuscles:** Respond to deep pressure and high-frequency vibration. Found deep in the dermis.

Types of Touch Receptors: Thermoreceptors

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- **Function:** Specialized receptors that detect changes in temperature.
 - **Location:** Found throughout the skin.
 - **Hot vs. Cold:** Separate receptors exist for detecting cold and for detecting heat. They respond to *changes* in temperature rather than steady temperatures.

Types of Touch Receptors: Nociceptors (Pain)

- **Function:** Sensory receptors that respond to stimuli that cause or threaten tissue damage (extreme pressure, temperature, or certain chemicals).
- **Importance:** Pain is a crucial protective mechanism, forcing us to withdraw from harmful stimuli.
- **Sensory Pathway:** Pain signals travel along fast (sharp pain) and slow (dull, aching pain) nerve fibers.

Sensory Disorders: Vision



- **Cataracts:** Clouding of the lens, reducing the amount of light that reaches the retina.
- **Glaucoma:** Damage to the optic nerve, often due to increased fluid pressure inside the eye.
- **Astigmatism:** An irregular shape of the cornea or lens, causing light to be improperly focused.

Sensory Disorders: Hearing

- **Conduction Deafness:** Hearing loss due to problems with the sound conduction in the outer or middle ear (e.g., ruptured eardrum, damaged ossicles).
- **Sensorineural Deafness:** Hearing loss due to damage to the hair cells in the cochlea or the auditory nerve. This is often permanent.



Thank you

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