

# Special senses

## SESSION OBJECTIVES

1. Compare the histological features of sensory receptors for vision, hearing, taste, touch, and smell.
2. Describe the organization of the anterior eye: cornea, lens, and structures that circulate aqueous humor; discuss common pathologies of each.
3. Describe the histology of the retina.
4. In the inner ear, explain the location and functions of the hair cells for the senses of balance and hearing; discuss causes of hearing loss.
5. Explain both taste buds and the olfactory receptor epithelium.

## OPTIONAL PRE-CLASS MATERIALS FOR THIS SESSION

- **Optional:** Skim the section titles, bolded terms, and image captions from Junqueira's Basic Histology, Chapters 23 ("The Eye & Ear: Special Sense Organs"), 15 (subheading: "Tongue"), and 17 (subheading: "Olfactory"). ([Click here for FMR library resources](#)) to fill in any knowledge gaps you feel you have.
- Pre-recorded videos:
  - [FMR – HISTO – Special Senses – Eye – Part 1](#) (26:44 min)
  - [FMR – HISTO – Special Senses – Eye – Part 2](#) (18:07 min)
  - [FMR – HISTO – Special Senses – Eye – Part 3](#) (17:23 min)
  - [FMR – HISTO – Special Senses – Eye – Part 4](#) (20:32 min)

## VISION:

The eyes are responsible for vision, analyzing the form, intensity, and color of light reflected from objects.

### Organization of the eye:

The eye is a fluid-filled sphere that houses the **lens** and is surrounded by three layers:

- The **fibrous tunic** (outermost layer) consists of the **sclera** (the white of the eye), which extends to the transparent **cornea** at the front.
- The **vascular tunic** (middle layer), which provides the eye with a blood supply and nutrients, includes the **choroid, ciliary body, and iris**.
- The **retina** (innermost layer) consists of two parts, the outer pigmented layer and the innermost neural layer containing three kinds of neurons.

Alternatively, the eye can be subdivided into the **anterior** and **posterior segments**:

- The posterior segment contains the **vitreous chamber/body**.
- The anterior segment is further divided (by the iris) into the **anterior** and **posterior chambers**.

**Knowledge check:** Label the parts of the eye



An interactive H5P element has been excluded from this version of the text. You can view it online here:  
<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-171>

**Optional Activity:** [Click for an overview of MAJOR structures of the eye](#)

#### **Aqueous humor:**

Produced in the posterior chamber, **aqueous humor** flows through the pupil into the anterior chamber.

**Knowledge check:** Trace the pathway of aqueous humor in the eye



An interactive H5P element has been excluded from this version of the text. You can view it online here:  
<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-172>

**Knowledge check:** Recall the function of aqueous humor



An interactive H5P element has been excluded from this version of the text. You can view it online here:  
<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-173>

#### **Optics of the eye:**

The cornea and lens focus the visual field image by refracting light to form an inverted and reversed miniature image on the retina.

**Knowledge check:** Trace the pathway of the visual signals from the retina to the brain



An interactive H5P element has been excluded from this version of the text. You can view it online here:  
<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-175>

#### **Vision Disorders and Diseases:**

Understanding the functions of the cornea, lens, and retina is essential for recognizing how different ocular diseases impact vision.

**Knowledge check:** Assess your knowledge of diseases affecting vision



An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-174>

### Eye-Opening Questions to Check Your Understanding:

1. What are the eye's three tunics and their major subparts?
2. What are the eye's segments and its anterior segment's two chambers?
3. How does the eye develop in the embryo?
4. How does aqueous humor form, circulate through the anterior eye, and drain away?
5. What are the layers of the neural retina as defined by photoreceptor cells, bipolar cells, and ganglion cells?
6. What are the causes of these disease states: glaucoma, cataracts, macular degeneration, and detached retina?

### HEARING and EQUILIBRIUM:

The ear consists of three main parts: the **outer ear**, the **middle ear** (which is filled with air and contains the smallest bones in the body), and the **inner ear** (which is responsible for hearing and balance).

#### Organization of the inner ear:

The inner ear, located within the temporal bone, consists of the **bony labyrinth** that contains the fluid-filled **membranous labyrinth**, a series of interconnected, epithelium-lined tubes and chambers. The labyrinth is divided into the **cochlea**, which enables hearing, and the **vestibular organs** (the **sacculle**, **utricle**, and **semicircular ducts**), which aid in balance and spatial orientation. The functions of these components are mediated by specialized **hair cells** that act as mechano-electrical transducers, converting the mechanical energy of detected movement and sound vibrations into electrical signals that are interpreted by the brain.

**Knowledge check:** Demonstrate your understanding of the inner ear's anatomical structure



An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-181>



An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-176>

**Optional Activity:** [Click for an overview of MAJOR structures of the ear](#)

#### Acoustics of the ear:

The ear converts sound waves into electrical signals for the brain to interpret.

**Knowledge check:** Test your knowledge on how the ear processes sound





An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-177>

### Disorders and Diseases of Hearing and Equilibrium:

Understanding the ear's anatomy and physiology is essential for diagnosing conditions that lead to hearing loss and balance disorders.

**Knowledge check:** Assess your knowledge of diseases affecting hearing (and balance!)



An interactive H5P element has been excluded from this version of the text. You can view it online here: <https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-178>

### Sound Check: Additional Questions to Consider

1. Can you define the external, middle, and internal ear?
2. Can you define and distinguish the bony and membranous labyrinths of the internal ear? Perilymph versus endolymph?
3. How do the hair-cell epithelia in the internal ear monitor fluid vibrations to sense balance and hearing? That is, work out the location, structure, and functions of the cristae and maculae.
4. Can you describe the spiral organ of Corti in the cochlea and how it signals the vestibulocochlear nerve of the auditory pathway?
5. What are the causes of these disease states: congenital deafness and conductive versus sensory hearing loss?

### OLFACTION (SMELL) and GUSTATION (TASTE):

Smell relies on olfactory chemoreceptors in the upper nasal cavity's olfactory epithelium, while taste is managed by taste buds on the tongue that detect and transmit flavor information to the brain. A detailed examination of the structure and organization of these sensory systems is essential for understanding their functions.

#### Olfactory organization:

Smell receptors are located in the **olfactory epithelium** at the top of the nasal cavity, where specialized **olfactory neurons** act as sensory receptors. Neurons extend their axons through the **cribriform plate** to the **olfactory bulb**; they are supported by **sustentacular** and **basal cells**, which can differentiate into new neurons and support cells. Underneath the olfactory epithelium are **Bowman's glands**, which produce secretions that dissolve odorants, allowing them to interact with approximately **350 types of G-protein-coupled receptors**. Notably, each neuron expresses only one type of olfactory receptor, and all neurons with the same receptor type synapse at the same glomerulus in the olfactory bulb.

**Knowledge check:** Describe where odorant receptors are located within the olfactory system.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-180>

#### Gustatory organization:

The tongue is covered in **papillae**, with **taste buds** primarily located on the larger **vallate papillae** near the terminal sulcus, as well as on **fungiform** and **foliate papillae**. Grooves around these papillae are filled with fluid from serous salivary glands, maintaining the taste buds' function. Each vallate papilla has about 250 taste buds made up of gustatory, supportive, and basal stem cells.

**Knowledge check:** Identify the five basic tastes detected by the human gustatory system.



An interactive H5P element has been excluded from this version of the text. You can view it online here:

<https://uw.pressbooks.pub/wwamihistopathology/?p=1537#h5p-179>

**Optional Activity:** Use these links to explore MAJOR structures of the tongue- [tongue1](#), [tongue2](#), [tongue3](#), [tongue4](#)

**Savor the difference: Scent-sational or Taste-tastic?**

1. How do the receptors for taste (in taste buds) differ from the receptors for smell (in the olfactory epithelium) in their location, receptor cells, and epithelial structure?

*This Chapter's PDF*

[HISTO: Special Senses](#)

- Note: The interactive features of this chapter are not reproducible in this PDF format.