Chapter 16:
The Special Senses

**Chapter objectives:**

1. Describe the structures of the Special Senses
2. Explain the pathways of sound in the ear and light in the eye
3. Identify, describe, and discuss the receptors and neural pathways involved in each of the five special senses

1. Taste
2. Smell
3. Sight
4. Hearing
5. Touch (Chapt 14)

Developed by John Gallagher, MS, DVM
The Chemical Senses: 1. Taste

- Chemoreceptors in **Taste Buds**
  - Mostly in papillae on the tongue
    - Circumvallate, fungiform
    - Each has groups of **gustatory cells**
- Sweet, Sour, Salt, Bitter, Umami
- CN VII and IX to medulla oblongata
The Chemical Senses: 1. Taste
The Chemical Senses: 2. Smell

- Olfactory Epithelium (CN I)
  - Receptors in pseudostratified epithelium in nasal conchae and septum
- Filaments from OE protrude through the Cribriform Plate of ethmoid bone
  - CN I runs to the Olfactory Bulb, and to the olfactory cortex of the cerebrum
Vision (Eye and Accessories)

Factoids:
- Most dominant sense
  - 70% of the body’s receptors are in the eyes
  - 40% of cortex dedicated to visual processing
- Most metabolically active tissue
- Medical careers:
  - Optician
  - Optometrist
  - Ophthalmologist
Dissected View

- Superior rectus muscle
- Lacrimal gland
- Lacrimal gland ducts
- Lateral canthus
- Lower eyelid
- Inferior rectus muscle
- Inferior oblique muscle
- Tendon of superior oblique muscle
- Lacrimal punctum
- Superior lacrimal canaliculus
- Medial canthus
- Inferior lacrimal canaliculus
- Lacrimal sac
- Nasolacrimal duct
- Opening of nasolacrimal duct
- Middle meatus
- Inferior nasal concha

(c) Dissection of right orbit
Palpebrae = Eyelids

- Continuation of skin
- Eyelashes
- Tarsal Plate of Hyaline C.

- Tarsal (Meibomian) glands on inner margin of lid
  - The oily portion of the tear film
  - Swollen gland = chalazion

- Conjunctiva (= mucous membrane)
  - Palpebral or Bulbar
  - Over cornea very thin (5-7 cells thick)
  - Conjunctivitis (pink eye)
Lacrimal Apparatus

- **Lacrimal gland** with several ducts - superior and lateral to eye
  - Secretion contains water, lysozyme, Ab, mucus
- **Lacrimal puncta** (superior and inferior) - holes next to the medial canthus to drain tears
- **Nasolacrimal duct** - empties to nasal cavity
Extrinsic Eye Muscles (review)

- 4 rectus muscles
  - Lateral (CN XI)
  - medial, superior, inferior (CN III)
- 2 obliques
  - Superior (CN IV)
  - Inferior (CN III)
The Globe (Eyeball)

Learn all of this chart!

3 tunics:

- Sclera
- Choroid
- Retina

Posterior cavity (vitreous) chamber

Anterior chamber

Fovea

Optic disc

Optic nerve

Central artery and vein

Optic nerve

Fovea

Central artery and vein

Optic nerve

Fovea

Central artery and vein

Optic nerve

Fovea

Central artery and vein

Optic nerve
The Three Layers (tunics):

1. **Fibrous Tunic (tough outer layer)**
   1. *sclera* - white part of fibrous tunic
   2. *cornea* - transparent anterior part
      1. Avascular: nutrition via diffusion
      2. pain receptors
      3. Layer of noncornified stratified squamous epithelium
   3. *limbus* - boundary between the above
The Three Layers (tunics):

2. Vascular Tunic (= Uvea)
   1. choroid –
      1. heavily vascular
      2. posterior aspect
   2. iris with pupil – inner
   3. sphincter and outer radial muscles
   4. ciliary body – (ciliary m.) attached to
   5. Radial suspensory ligaments (ciliary zonule)
      1. regulates focus of lens
3) **The Sensory Tunic**

AKA Nervous Tunic, retina

- Outer layer pigmented - inner layer photoreceptors $10^6$
  - a) rods - black/white vision, dim light
  - b) cones - color vision, intense light

- Bipolar cells - synapse with rods and cones
- Ganglion cells - synapse with bipolar cells
- Ora serrata - anterior edge of retina
- Macula lutea – fovea centralis - all cones, best vision
- Optic disc – blind spot, where optic nerve exits eye
- Optic nerve (CN II)
Retina

(a) Diagram showing layers of the retina including:
- Choroid
- Pigmented layer of retina
- Horizontal cell
- Rod cell
- Cone cell
- Photoreceptors
- Bipolar cells
- Ganglion cells
- Axons of ganglion cells

(b) Micrograph showing:
- Choroid
- Pigmented layer of retina
- Outer segments of rod and cone cells
- Nuclei of ganglion cells
- Nuclei of rod and cone cells
- Nuclei of bipolar cells

Pathway of light is indicated in (a).
Retina

- Photoreceptors
  - Infolding membranes contain photopigments
- Rods
  - Most numerous
  - Non-acute vision
- Cones
  - Concentrated in macula
  - Color vision – red, green blue
Eye Fundus:

Age Related Macular Degeneration
Chambers of the Eye

- Posterior Segment
  - Vitreous Humor
- Anterior Segment—filled with aqueous humor
  - Anterior chamber = between iris and cornea
  - Posterior Chamber = between lens and iris
- Posterior cavity with vitreous humor
Vision Terminology

- Emmetropia = Normal vision
- Hyperopia = Farsightedness
- Myopia = Nearsightedness
- Presbyopia = Poor close-up vision with aging
- Astigmatism = Abnormal shape of the surface of the lens and/or cornea
- Cataract = abnormal crystallization of the lens, common in diabetes, injury, heredity
- Amblyopia = Poor vision in a normal eye (CNS defect)
Visual Pathway

Optic chiasma - optic nerves partially cross (right side of the field of each eye combining and going to the lateral geniculate on the right, those from the left to the left)

To superior colliculus and thalamus and visual cortex in occipital lobe
The Ear

Hearing
Balance (equilibrium)
CN VIII

1. External ear
2. Middle ear
3. Inner ear
1. External Ear

- Auricle or Pinna
  - Elastic Cartilage
- External ear canal
  - Through the external acoustic meatus
  - Ceruminous glands
    - Cerumen (ear wax)
  - In what bone??

![Diagram of the external ear with labeled parts: Auricle, External ear canal, Cerumen, and Placement in bone.](image)
2. Middle Ear

- Tympanic membrane
- Three Auditory Ossicles
  - Incus, Malleus, Stapes
  - Transmit Vibrations to Inner Ear
- Eustachian Tube = Auditory Tube = Pharyngotympanic Tube

Otitis media
3. Inner Ear

- Cochlea
- Vestibular complex
Structure of cochlea:
2.5 turns of ducts
Organ of Corti

Basilar membrane on which sit hair cells with stereocilia

Tectorial membrane above the hair cells

Sound causes hair cells to bounce and touch tectorial membrane causing transduction
Vestibular Complex

- Vestibule
  - Saccule
  - Utricle
  - Static equilibrium
- Three **semicircular canals** with ampullae (mutually perpendicular)
  - Linear acceleration

Each has a macula with receptors
Two Receptor Organs of vestibule

- Two Maculae
  - or: macula of saccule plus macula of utricle
  - Vertical and horizontal orientation
  - Contain otoliths that move according to gravity
  - Hair cells conduct impulse to CN VIII
Semicircular Canals

- Oriented perpendicular
  - Anterior
  - Posterior
  - Lateral
- Each has an ampulla
  - Crista ampullaris bends
Cochlear branch of CN VIII

From cochlea:

To cochlear nucleus of medulla

Decussation

To inferior colliculus of opposite side of midbrain

To thalamus

To auditory cortex