Chapter 11: The Sensory System

The Senses

Sensory Receptors

- Receptor classification based on structure
  - Free dendrite – such as a pain receptor
  - End-organ – such as those for touch
  - Specialized cell – such as rods or cones

- Receptor classification based on stimulus
  - Chemoreceptor – detect chemicals in solution
  - Photoreceptor – in the eye, respond to light
  - Thermoreceptor – detect changes in temperature
  - Mechanoreceptor – respond to movement
  - Proprioreceptors – located in muscles, tendons, and joints, aid in judging body position (this is a general sense, not a special sense because of its wide distribution throughout the body)

Sensory Adaptation

- Occurs when receptors are exposed to continuous stimulus
- Some receptors can adjust themselves so sensation becomes less acute.
- Receptors adapt at different rates.
- Pain receptors do not adapt.

Special Senses - localized in specific organs
- General Senses - widely distributed throughout body
- Vision
- Hearing
- Equilibrium
- Taste
- Smell
- Pressure
- Temperature
- Pain
- Touch
- Sense of position

Sensory Adaptation

- Receptors often become less sensitive to a continuous unimportant stimulus.
  - Such as putting on clothes, getting into bath
The Eye and Vision

Protective Structures of the Eye

- Bony orbit – protects the posterior of eyeball
- Eyelids – close to keep materials out; blinking lubricates
- Eyelashes/brows – keep foreign matter out
- Conjunctiva – thin clear membrane that covers sclera
- Lacrimal glands – produce tears to lubricate and fight infection

Why do we blink?

Structure of the Eyeball - has three separate coats (tunics)

1. Outside fibrous tunic composed of:
   - Sclera – outside fibrous white layer;
   - Cornea – continuation of sclera, but clear; rounded shape to refract light

2. Vascular tunic – composed of
   - Choroid – delicate network of blood vessels
   - Ciliary muscle & suspensory ligaments which hold the lens in place and change its shape
   - Iris – colored area that controls how much light enters the eye

3. Innermost nervous tunic composed of the retina
   - Comprised of light sensitive cells: rods and cones

What anterior structure is continuous with the sclera?
The Eye and Vision

Pathway of Light Rays and Refraction

Refraction – the bending of light rays as they go through substances of different density

- Transparent parts of the eye that refract light
  - Cornea – main refracting structure, curved forward
  - Aqueous humor – watery fluid behind cornea
  - Crystalline lens – clear, circular, firm, biconvex, elasticity allows for focusing of objects on retina
  - Vitreous body – fills the interior of the eye and holds its shape
  - Retina – light hits the retina at the fovea centralis

Function of the Retina

- Rod cells – there are about 120 million in each eye
  - Function in dim light; highly sensitive, but not providing clear images
  - Dark adaptation – when rods start functioning after entering a dark room
  - Use the pigment rhodopsin
- Cone cells – localized in the fovea centralis/macula
  - Function in bright light
  - Enable color vision and images are very sharp
  - 3 types – red, green & blue; color blindness is a deficiency in the number of cones

Muscles of the Eye

- Adjust eye so retina receives clear images
  - Extrinsic muscles – on outside attached to sclera
    - Voluntary – move eyeball
    - Convergence enables three-dimensional vision
    - frame game
  - Intrinsic muscles – within eyeball
    - Iris regulates amount of light entering eye
    - Ciliary muscle shapes lens for near and far vision (called accommodation)

What muscles of the iris contract to make the pupil smaller? Larger?
The Eye and Vision

Nerve Supply to the Eye
- Sensory nerves:
  - Optic nerve (CN II) - carries visual impulses to brain
  - Trigeminal nerve (CN V) - carries impulses of pain, touch and temperature

Eye Disorders -
A
Short eyeball
- Hyperopia (farsightedness)
- Corrected

B
Flat eyeball
- Myopia (nearsightedness)
- Corrected

Strabismus
Lazy eye; poor eyeball muscle coordination
Astigmatism

Irregular curvature of the cornea or lens causes multiple focal points

5. Cataracts

Cloudy lens; can be taken out and replaced with new ones

6. Conjunctivitis

- Inflammation of the tear film (conjunctiva)

7. Retinal Detachment

- Retina pulls away from choroid

8. Macular degeneration

- Deterioration of the fovea centralis nerve endings

9. Glaucoma

- Excess pressure of aqueous humor causes nerves to die
- Peripheral vision is lost first
**The Ear**

**The Outer Ear**
- Pinna – external ear flap (collects sound waves and directs them to canal)
- External auditory canal – 2.5cm leads to eardrum
- Ceruminous glands – line the inside of the canal, secrete cerumen (ear wax)
- Tympanic membrane – thin membrane at end of canal, vibrates with sound waves

**The Middle Ear**
- Ossicles – three small bones that transmit sound through the middle ear
  1. Malleus – between eardrum and incus
  2. Incus – between malleus and stapes
  3. Stapes – between incus and cochlea; covers the oval window
- Auditory (eustachian) tube – connects middle ear to throat; relieves pressure inside

**Inner Ear**
- Structure
  - Bony labyrinth; contains perilymph
- Divisions
  - Vestibule – chamber with receptors for equilibrium (head movement)
  - Semicircular canals – 3 tubes with receptors for equilibrium of body movement
  - Cochlea – snail shape shell with receptors for hearing
- Function - Transduce sound waves into nerve impulses
The Ear

The Steps in Hearing
1. Sound waves enter external auditory canal
2. Tympanic membrane vibrates
3. Ossicles transmit vibrations across middle ear
4. Stapes transmits vibrations at oval window to inner ear fluid

The Ear (continued)
5. Vibrations travel through perilymph of bony labyrinth
6. Spiral organ’s hair cells vibrate against tectorial membrane, generating nerve impulses
7. Impulses travel via cochlear nerve to temporal lobe cortex, where they are interpreted
8. Sound waves leave inner ear through the round window

Equilibrium
1. Vestibule – open chamber with receptors for equilibrium for head position
2. Semicircular canals – 3 tubes that register equilibrium of body position

Figure 11-16 Action of the vestibular equilibrium receptors (maculae).

What happens to the cilia of the macular cells when the fluid around them moves?

Figure 11-17 Action of the equilibrium receptors (cristae) in the semicircular canals.

The Ear

a. Ear infection – of middle ear, called *otitis media*
b. Hearing loss – deafness can occur two ways
   - Conductive hearing loss – interference from outside to inside of ear (ie. ear wax build up)
   - Sensorineural hearing loss – deficiency of cochlea, brain, or auditory nerve
c. Vertigo – sensation of you or environment spinning; caused by inner ear inflammation
Other Special Sense Organs

Sense of taste (gestation)
- Receptors (taste buds)
  - Sweet
  - Salty
  - Sour
  - Bitter
  - Umami
- Nerve supply
  - Facial nerve
  - Glossopharyngeal nerve

Sense of Smell
- Smell receptors in nasal cavity
  - Stimulated by substances in solution in nasal fluids
  - Smells stimulate appetite and flow of digestive juices
- Olfactory nerve (cranal nerve I)

The General Senses
- Receptors scattered throughout the body sense
  - Touch
  - Pressure
  - Heat
  - Cold
  - Position
  - Pain

Referred Pain – pain that originates in an internal organ is felt in a superficial part of the body

Word Anatomy

<table>
<thead>
<tr>
<th>Word Part</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>ophthalm/o</td>
<td>eye</td>
<td>An ophthalmologist is a physician who specializes in treatment of the eye.</td>
</tr>
<tr>
<td>presby-</td>
<td>old</td>
<td>Presbyopia is farsightedness that occurs with age.</td>
</tr>
<tr>
<td>tympan/o</td>
<td>drum</td>
<td>The tympanic membrane is the eardrum.</td>
</tr>
<tr>
<td>ot/o</td>
<td>ear</td>
<td>Otitis is inflammation of the ear.</td>
</tr>
<tr>
<td>propri/o</td>
<td>own</td>
<td>Proprioception is perception of one’s own body position.</td>
</tr>
<tr>
<td>algis/i</td>
<td>pain</td>
<td>An analgesic is a drug that relieves pain.</td>
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