

9

The General and Special Senses

FOCUS: The general senses are distributed throughout the body and include touch, pain, temperature, and proprioception (awareness of body position). Receptors for the general senses are found in the skin, tendons, ligaments,

muscles, and body organs. The special senses involve localized organs in the head. These organs have very specialized sensory cells, and include smell (olfaction), taste, sight (vision), hearing, and balance (equilibrium).

CONTENT LEARNING ACTIVITY

Introduction

“*The senses are the means by which the brain receives information.*”

Match these terms with the correct statement or definition:

General senses
Projection
Sensation

Special senses
Stimulus

1. Anything that causes a response in a tissue.
2. Conscious awareness of a stimulus.
3. The perception that a sensation originates from the part of the body stimulated.
4. Includes smell, taste, sight, hearing, and balance.
5. Includes touch, pressure, pain, temperature, vibration, itch, and proprioception.

General Senses

“The general senses are distributed throughout the body.”

Match these terms with the correct statement or definition:

Free nerve endings
Hair follicle receptors
Meissner's corpuscles

Merkel's disks
Pacinian corpuscles
Ruffini's end-organs

1. Respond to pain, temperature, and itch.
2. Detect light touch and superficial pressure; located in the epidermis; a capsule surrounding a nerve ending.
3. Respond to fine, discriminative touch; located just deep to the epidermis.
4. Monitor continuous touch or pressure in the skin.
5. Detect deep pressure, vibration, and position (proprioception); located in tendons and joints.

Pain

“Pain is a sensation characterized by a group of unpleasant perceptual and emotional experiences.”

Using the terms provided, complete these statements:

Diffuse
Dorsal columns
Lateral spinothalamic tract
Localized

Nerve
Phantom pain
Referred pain
Reticular formation

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

There are two kinds of pain. Rapidly conducted impulses give rise to sharp (1), pricking pain, whereas slowly propagated impulses give rise to (2), burning, aching pain. Local anesthesia suppresses pain by injecting chemicals near a (3). General anesthesia uses chemicals to inhibit consciousness in the (4). According to the gate-control theory, pain sensations (action potentials) transmitted in the (5) can be blocked by increased activity of the (6). A painful sensation in a region of the body that is not the source of the pain stimulus is called (7). The perception of pain in the part of an appendage that has been amputated and is no longer present is called (8).



Rubbing the skin, exercise, acupuncture, and acupressure may alleviate pain by activating dorsal column neurons that block pain transmission through the lateral spinothalamic tract.

Olfaction

“Olfaction occurs in response to airborne molecules that enter the nasal cavity.”

Match these terms with the correct statement or definition:

Olfactory bulb
Olfactory cortex
Olfactory nerve

Olfactory neurons
Olfactory tract

1. Specialized cells in the epithelium of the nasal cavity; airborne molecules bind to receptors on these cells, producing action potentials.
2. Formed by axons from the olfactory neurons; pass through the cribriform plate.
3. Receives the olfactory nerves.
4. Relays action potentials from the olfactory bulb to the brain.
5. Area of the frontal and temporal lobes that receives the olfactory tract.



Combinations of primary odors enable the detection of a wide variety of odors.

Taste

“Taste occurs in response to molecules dissolved in fluid within the oral cavity.”

Match these terms with the correct statement or definition:

Back of tongue
Facial nerve
Glossopharyngeal nerve
Papillae

Side of tongue
Taste bud
Taste cell
Tip of tongue

1. Sensory structure that detects taste stimuli.
2. Enlargements on the surface of the tongue; contain taste buds.
3. Makeup a taste bud; each has taste hairs that extend through a taste pore.
4. Taste sensations from the anterior two thirds of the tongue are conducted by this nerve.
5. Taste buds located on this part of the tongue respond most strongly to sweet and salty tastes.
6. Taste buds located on this part of the tongue respond most strongly to bitter tastes.
7. Taste buds located on this part of the tongue respond most strongly to sour tastes.

Vision: Accessory Structures

“Accessory structures protect, lubricate, and move the eye.”

Match these terms with the correct statement or definition:

Conjunctiva
Eyebrows
Eyelids
Extrinsic eye muscles

Lacrimal canaliculi
Lacrimal gland
Nasolacrimal duct

1. Prevent perspiration from running down the forehead into the eye.
2. Protect the eye from foreign objects and lubricate the eye by spreading tears.
3. Thin, transparent membrane that covers the anterior surface of the eye and the inner surface of the eyelids.
4. Produces tears.
5. Collect excess tears from the medial corner of the eye.
6. Empties excess tears into the nasal cavity.
7. Move the eyeball.

Anatomy of the Eye

“The eye is composed of three coats or tunics.”

A. Match these terms with the correct statement or definition:

Cornea
Fibrous tunic
Nervous tunic

Sclera
Vascular tunic

1. Outer layer of the eye, consisting of the sclera and cornea.
2. Middle layer of the eye, consisting of choroid, ciliary body, and iris.
3. Inner layer of the eye, consisting of the retina.
4. Firm, opaque, white, outer posterior five sixths of the eye; maintains the shape of the eye and provides an attachment site for the extrinsic eye muscles.
5. Avascular, transparent, anterior one sixth of the eye; allows light to enter the eye and also refracts light.

B. Match these terms with the correct statement or definition:

Choroid
Ciliary body
Iris

Lens
Pupil

1. Vascular tunic associated with the scleral portion of the eye; prevents light reflection.
2. Contains ciliary muscles (smooth muscles) that attach by suspensory ligaments to the lens.
3. Flexible, biconvex, transparent disc.
4. Contains smooth muscle that regulates the amount of light entering the eye.
5. The opening in the iris through which light passes.

C. Match these terms with the correct statement or definition:

Cones
Pigmented retina
Rhodopsin

Rods
Sensory retina

1. Outer part of the retina; its black color prevents light reflection.
2. Inner part of the retina containing rods and cones.
3. Photoreceptor cells that are very sensitive to light and function in dim light.
4. Photoreceptor cells responsible for color vision.
5. Photopigment in rods that breaks down when struck by light; vitamin A is necessary for its manufacture; lack of vitamin A results in night blindness.



There are three types of cones, each sensitive to a different color: blue, green, or red.

D. Match these terms with the correct statement or definition:

Aqueous humor
Fovea centralis
Macula lutea

Optic disc
Vitreous humor

1. Small yellow spot near the center of the posterior retina.
2. Small pit with the highest concentration of cones and the greatest ability to most clearly detect images; located in the macula lutea.
3. Blind spot of the eye; place where blood vessels and the optic nerve pass through the wall of the eye.
4. Fills the anterior compartment of the eye; maintains pressure, refracts light, and provides nutrients to the inner eye surface.
5. Fills the posterior compartment of the eye; helps to maintain pressure within the eye and holds the lens and retina in place.



Glaucoma is a build up of pressure within the eye that can result in blindness.

E. Match these terms with the correct parts labeled in figure 9.1:

Anterior compartment
Choroid
Ciliary body
Conjunctiva
Cornea
Iris
Lens

Optic nerve
Posterior compartment
Pupil
Retina
Sclera
Suspensory ligaments
Vitreous humor

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

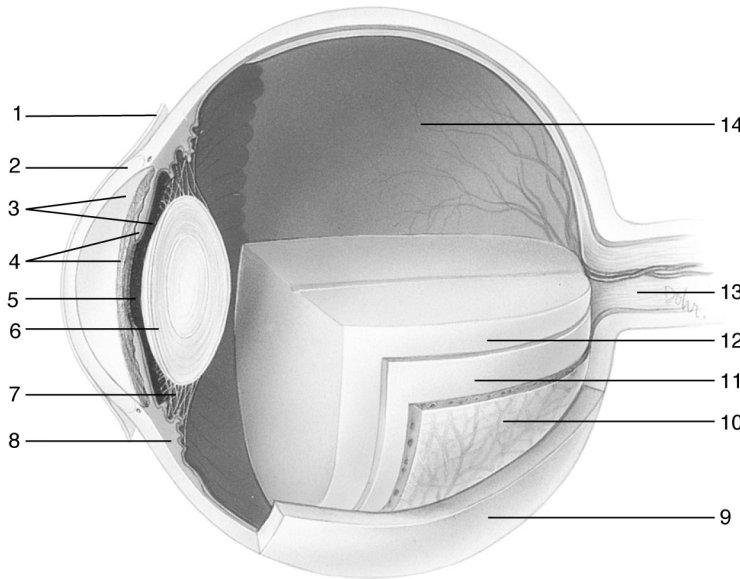


Figure 9.1

Functions of the Complete Eye

“The eye functions much like a camera.”

A. Match these terms with the correct statement or definition:

Concave lens
Convex lens
Focal point

Focusing
Refraction

- _____
- _____
- _____
- _____
- _____

1. Bending of light rays as they pass from air into some other, more dense substance.
2. Type of lens that causes light rays to diverge.
3. Type of lens that causes light rays to converge.
4. Where converging light rays cross.
5. Act of causing light rays to converge to form an image.

B. Match these terms with the correct statement or definition:

Accommodation
Contracted
Cornea

Lens
Relaxed

1. Part of the eye that produces the greatest amount of convergence of light.
2. Part of the eye that accomplishes fine adjustments in focusing by changing shape.
3. Process of allowing the lens to assume a more spherical (convex) shape; enables the eye to focus objects that are closer than 20 feet.
4. Condition of the ciliary muscles during accommodation.
5. Condition of the ciliary muscles for distant vision (greater than 20 feet).

C. Match these terms with the correct statement or definition:

Optic chiasma
Optic nerve
Optic radiations

Optic tract
Visual cortex
Visual field

1. Leaves the eye and passes through the optic foramen.
2. Point where some of the axons in the optic nerves cross to opposite sides of the brain.
3. Axons between the optic chiasma and the thalamus.
4. Axons extending from the thalamus to the visual cortex.
5. Part of the occipital lobes of the brain responsible for vision.
6. Image seen by each eye.

The Ear and Its Functions

“The external, middle, and inner ear are involved in hearing; balance is a function of the inner ear.”

A. Match these terms with the correct statement or definition:

Auricle
Cerumen

External auditory meatus
Tympanic membrane

1. Fleishy part of the external ear on the outside of the head.
2. Passageway that leads to the tympanic membrane.
3. Modified sebum, commonly called earwax, that helps to prevent foreign objects from reaching the tympanic membrane.
4. Thin membrane that separates the external and middle ear; vibrates in response to sound waves; also called the eardrum.

B. Match these terms with the correct statement or definition:

Auditory ossicles
Auditory tube
Mastoid air cells

Oval window
Round window

1. Opening between the middle and inner ear; contains the stapes.
2. Membrane-covered opening between the middle and inner ear.
3. Ear bones that transmit and amplify vibrations of the tympanic membrane to the oval window; the malleus, incus and stapes.
4. Spaces in the temporal bone that are connected to the middle ear.
5. Structure that enables air pressure to be equalized between the outside air and the middle ear; the eustachian tube.

C. Match these terms with the correct statement or definition:

Cochlea
Endolymph
Membranous labyrinth
Osseous labyrinth

Perilymph
Semicircular canals
Vestibule

1. Interconnecting tunnels and chambers within the temporal bone.
2. Membranes that are found within the osseous labyrinth.
3. Fluid within the membranous labyrinth.
4. Fluid between the osseous and membranous labyrinth.
5. Part of the inner ear involved with hearing.
6. Two parts of the inner ear involved with balance.

D. Match these terms with the correct parts labeled in figure 9.2:

- Auditory ossicles
- Auditory tube
- Auricle
- Cochlea
- External auditory meatus
- External ear
- Incus
- Inner ear
- Malleus
- Oval window
- Round window
- Semicircular canals
- Stapes
- Tympanic membrane
- Vestibule

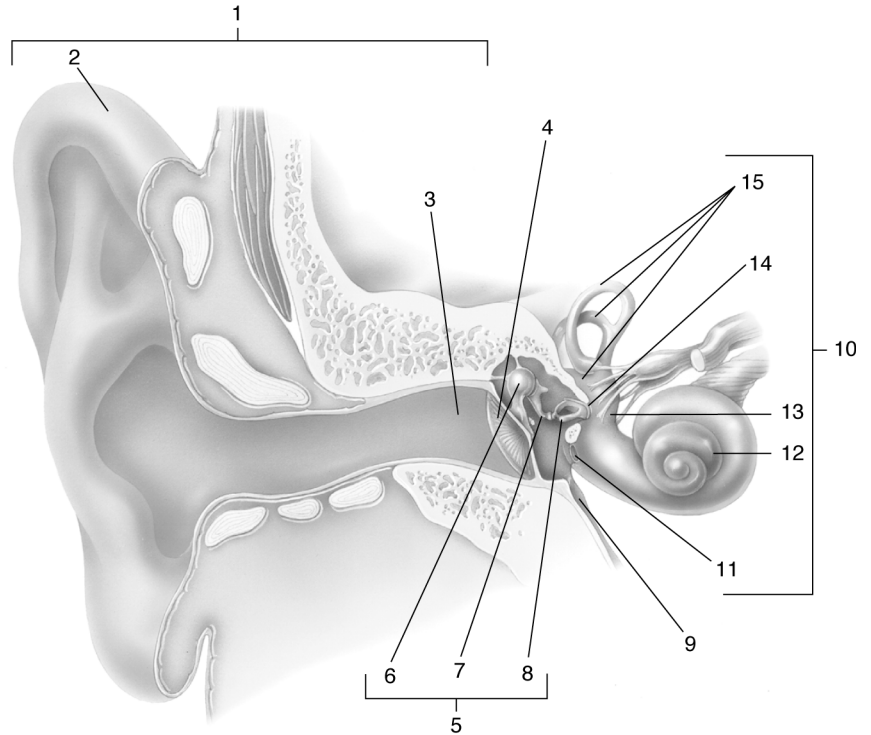


Figure 9.2

- | | | |
|----------|-----------|-----------|
| 1. _____ | 6. _____ | 11. _____ |
| 2. _____ | 7. _____ | 12. _____ |
| 3. _____ | 8. _____ | 13. _____ |
| 4. _____ | 9. _____ | 14. _____ |
| 5. _____ | 10. _____ | 15. _____ |

Hearing

“Sound waves are converted into action potentials that the brain interprets as sound.”

A. Match these terms with the correct statement or definition:

- Basilar membrane
- Cochlear duct
- Scala tympani

- Scala vestibuli
- Tectorial membrane
- Vestibular membrane

- _____
- _____
- _____
- _____
- _____
- _____

1. Membrane separating the scala vestibuli and the cochlear duct.
2. Membrane separating the scala tympani and the cochlear duct.
3. The space that connects to the oval window.
4. The space that connects to the round window.
5. The space that contains the spiral organ.
6. The spiral organ rests on the basilar membrane and its hair cells extend to this membrane.

B. Using the terms provided, complete these statements:

Auricle
Incus
Malleus
Oval window
membrane

Perilymph
Round window
Stapes
Tympanic

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Sound waves in the air are collected by the (1) and conducted by the external auditory meatus to the (2), which vibrates. The vibrations are transferred to the auditory ossicles. Vibration of the (3), which is attached to the tympanic membrane, causes vibration of the (4), which is attached to the (5). Movement of the stapes within the (6) produces vibrations in the (7) of the scala vestibuli. Because the scala vestibuli is connected to the scala tympani, perilymph movement causes the membrane of the (8) to move.

C. Using the terms provided, complete these statements:

Action potentials
Basilar
Endolymph
Hair cells

Pitch
Tectorial
Vestibular
Volume

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Movement of the stapes within the oval window produces vibrations of the perilymph of the scala vestibuli. The vibrations of the perilymph cause the (1) membrane to vibrate. The vibration of this membrane causes the (2) of the cochlear duct to vibrate, which in turn causes the (3) membrane to vibrate. The spiral organ rests on this membrane, and as the membrane moves it cause the (4) of the spiral organ, which are embedded in the (5) membrane to bend. The bending of the hair cells results in the production of (6) that are conducted to the brain through the cochlear branch of the vestibulocochlear nerve. Sounds with different (7) cause different regions of the basilar membrane to vibrate, whereas sounds with increased (8) cause the basilar membrane to vibrate more intensely.

D. Match these terms with the correct parts labeled in figure 9.3:

- Basilar membrane
- Cochlear duct
- Membranous labyrinth
- Oval window
- Round window
- Scala tympani
- Scala vestibuli
- Spiral organ
- Tectorial membrane
- Vestibular membrane

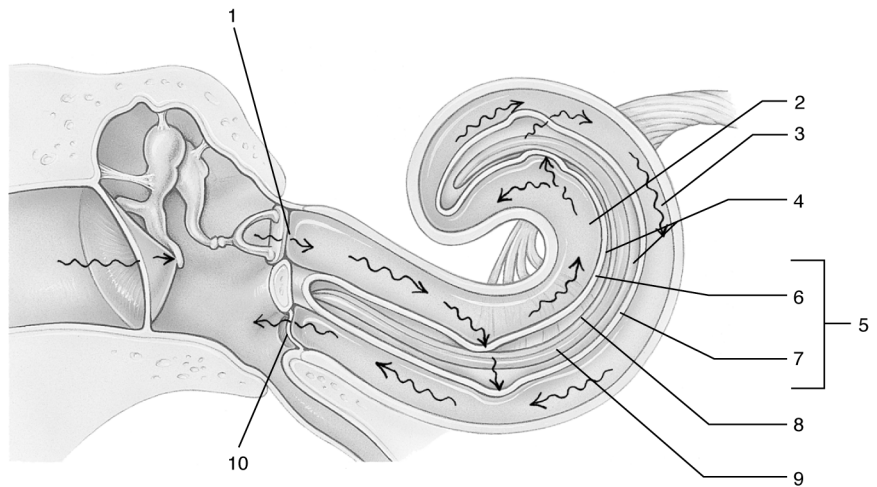


Figure 9.3

- | | | |
|----------|----------|-----------|
| 1. _____ | 5. _____ | 8. _____ |
| 2. _____ | 6. _____ | 9. _____ |
| 3. _____ | 7. _____ | 10. _____ |
| 4. _____ | | |

Equilibrium

“The sense of equilibrium has two components: static and kinetic equilibrium.”

Match these terms with the correct statement or definition:

- | | |
|---------------------|--------------------|
| Crista ampullaris | Saccule |
| Kinetic equilibrium | Static equilibrium |
| Macula | Utricle |

- | | |
|-------|--|
| _____ | 1. Type of equilibrium associated with the vestibule and involves evaluating the position of the head relative to gravity. |
| _____ | 2. Type of equilibrium associated with the semicircular canals and involves evaluating the change in rate of head movements. |
| _____ | 3. The two chambers of the vestibule. |
| _____ | 4. Specialized epithelium of the vestibule; consists of hair cells embedded in a gelatinous mass that contains otoliths. |
| _____ | 5. Specialized epithelium found in the ampulla; consists of hair cells embedded in a gelatinous mass called the cupula. |

QUICK RECALL

1. List the sensations produced through the general senses and the special senses.
2. List the six types of receptors associated with the general senses.
3. List the four basic tastes detected by the taste buds.
4. List the three coats or tunics of the eye.
5. Name the two major compartments of the eye and the substance that fills each.
6. Name the two types of photoreceptor cells and state their functions.
7. List the three parts of the bony labyrinth and give their function.
8. Name the structures that relieve pressure in the middle ear and the inner ear.
9. State the two type of equilibrium and the parts of the ear responsible for each.

WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
cochl-	a snail shell	1. _____
scler-	hard	2. _____
vitr-	glassy	3. _____
fove-	a pit	4. _____
oto-	ear	5. _____
lith-	a stone	6. _____

MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

- | | |
|---|--|
| <p>_____ 1. The type of receptor associated with pain and itch sensations.</p> <ul style="list-style-type: none"> a. Merkel's disks b. Pacinian corpuscles c. Meissner's corpuscles d. free nerve endings <p>_____ 2. Pain sensations</p> <ul style="list-style-type: none"> a. are conducted rapidly or slowly. b. can be blocked by input from the dorsal columns. c. can be felt at body locations that are not a source of pain stimulation. d. all of the above <p>_____ 3. Olfactory neurons</p> <ul style="list-style-type: none"> a. have projections called cilia. b. have axons that combine to form the olfactory nerves. c. connect to the olfactory bulb. d. have receptors that react with molecules dissolved in fluid. e. all of the above | <p>_____ 4. Taste</p> <ul style="list-style-type: none"> a. is detected by receptors called papillae. b. sensations from the posterior one third of the tongue are conducted through the facial nerve. c. can be divided into four basic types: sour, salty, bitter, and sweet. d. all of the above <p>_____ 5. Tears</p> <ul style="list-style-type: none"> a. are released onto the surface of the eye near the medial corner of the eye. b. in excess are removed by the eustachian tube. c. are carried to the back of the throat and swallowed. d. lubricate and clean the eye, and protect against eye infections. |
|---|--|

- _____ 6. Given the following structures:
1. choroid
 2. retina
 3. sclera

Choose the arrangement that list the structures in the order a pin would pass through them going from the outside of the eye to the inside.

- a. 1, 2, 3
- b. 2, 1, 3
- c. 2, 3, 1
- d. 3, 1, 2
- e. 3, 2, 1

- _____ 7. Aqueous humor
- a. is the pigment responsible for the black color of the choroid.
 - b. is produced by the iris.
 - c. returns to the blood through the lacrimal canaliculi.
 - d. in excess can cause cataracts.
 - e. produces pressure that keeps the eye inflated.

- _____ 8. Given the following structures:
1. lens
 2. aqueous humor
 3. vitreous humor
 4. cornea

Choose the arrangement that lists the structures in the order that light entering the eye would encounter them.

- a. 1, 2, 3, 4
- b. 1, 4, 2, 3
- c. 4, 1, 2, 3
- d. 4, 2, 1, 3
- e. 4, 3, 1, 2

- _____ 9. When light strikes rods, a series of chemical events occur that result in production of action potentials. Given the following events:

1. retinal attaches to opsin; ATP molecules are required
2. retinal changes shape
3. retinal separates from opsin

Choose the arrangement that list the events in the order they occur.

- a. 1, 2, 3
- b. 2, 1, 3
- c. 2, 3, 1
- d. 3, 1, 2
- e. 3, 2, 1

- _____ 10. Assume that you are looking at an object that is 20 feet away from you. If you suddenly look at an object that is 1 foot away, which of the following events would occur?

- a. ciliary muscles contract and the lens flatten
- b. ciliary muscles contract and the lens becomes more spherical (rounder)
- c. the ciliary muscles relax and the lens flatten
- d. the ciliary muscles relax and the lens becomes more spherical

- _____ 11. Which structure is found within or is part of the external ear?

- a. cochlea
- b. auditory tube
- c. auditory ossicles
- d. auricle

- _____ 12. Given the following structures:

1. perilymph
2. endolymph
3. vestibular membrane
4. basilar membrane

Choose the arrangement that lists the structures in the order sound waves coming from the outside would encounter them.

- a. 1, 3, 2, 4
- b. 1, 4, 2, 3
- c. 2, 3, 1, 4
- d. 2, 4, 1, 3

- _____ 13. Given the following structures:

1. stapes within the oval window
2. membrane of the round window
3. tympanic membrane

Choose the arrangement that lists the structures in the order sound coming from the outside causes them to move.

- a. 1, 2, 3
- b. 2, 1, 3
- c. 2, 3, 1
- d. 3, 1, 2
- e. 3, 2, 1

- _____ 14. The spiral organ
- rests upon the vestibular membrane.
 - has hair cells that are embedded in the tectorial membrane.
 - is located in the vestibule.
 - is located in scala tympani.

- _____ 15. Damage to the sensory structures in the semicircular canals would
- damage the macula.
 - damage the spiral organ.
 - affect the ability to detect the position of the head relative to the ground.
 - affect the ability to detect movement of the head.



FINAL CHALLENGES



Use a separate sheet of paper to complete this section.

- A man has constipation that causes distention and cramping of his colon. What kind of pain would he experience and where would the pain be located? Explain.
- An anatomy and physiology student conducted a test on the sense of taste. A volunteer was blindfolded and then asked to identify by taste items placed on her tongue. For each of the items, predict the likelihood that the volunteer will correctly identify the item.
 - sugar water placed on the tip of the tongue
 - unsweetened tea placed on the tip of the tongue
 - the tongue is dried and a few sugar crystals are placed on the tip of the tongue
- The main way that people "catch" colds is through their hands. After touching an object contaminated with the cold virus, the person transfers the virus to the nasal cavity where it causes an infection. Other than the obvious entry of the virus through the nose, how could the virus get into the nasal cavity?
- A woman develops a cataract in her right eye that interferes with her vision. Consequently she has the lens of the right eye removed. How would this affect her vision in the right eye? What kind of lens would you recommend to help her see better? (hint: see essay on eye disorders)
- Compared to their normal position when a person is standing upright, if the hair cells in the macula were stretched (not bent), in what position would a person be relative to the ground? Explain.