Pre-Lab Activity 1:
1. chemoreceptor
2. olfactory, cribriform, ethmoid
3. facial and glossopharyngeal

Pre-Lab Activity 2:
1. a. sclera  
   b. cornea  
   c. pupil  
   d. aqueous humor  
   e. lens  
   f. iris  
   g. ciliary body  
   h. choroid coat  
   i. retina  
   j. optic nerve  
   k. vitreous humor  
2. a. 4, 5  
   b. 3  
   c. 1  
   d. 3  
   e. 2  
   f. 3  
   g. 5  
   h. 1

Pre-Lab Activity 3:
1. The cow eye has a reflective layer called the tapetum lucidum.
2. adipose

Pre-Lab Activity 4:
1. cones
2. astigmatism
3. elasticity of the lens decreases dramatically
Pre-Lab Activity 5:

1. a. auricle  
   b. malleus  
   c. external auditory canal  
   d. semicircular canal  
   e. vestibule  
   f. stapes  
   g. tympanic membrane  
   h. incus  
   i. cochlea

2. a. 2  
   b. 3  
   c. 4, 5  
   d. 6  
   e. 1, 2  
   f. 1  
   g. 3, 4, 5  
   h. 3

3. b

Pre-Lab Activity 6:

1. Weber, Rinne  
   2. Romberg

ANSWERS TO ACTIVITY QUESTIONS

Activity 1

A. Olfactory and Gustatory Structures

1. Student sketch

2. CN VII, IX, X

3. a. Olfactory epithelium **houses chemoreceptors**  
   b. Fibers of olfactory nerve **carry electrical impulses to olfactory bulb**  
   c. Olfactory foramina **openings in cribriform plate through which olfactory nerve fibers travel**  
   d. Olfactory bulb **transmits olfactory messages to the olfactory tract**  
   e. Olfactory tract **transmits olfactory messages to the cerebral cortex**

B. Demonstrating the Effect of Olfaction on Gustation

1. a. Student prediction  
   b. Answers will vary.

5. Results and analysis:
### Food Sample

<table>
<thead>
<tr>
<th></th>
<th>(1) No Chewing, Eyes and Nostrils Closed</th>
<th>(2) Chewing, Eyes and Nostrils Closed</th>
<th>(3) Chewing, Eyes Closed and Nostrils Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Student data</td>
<td>Student data</td>
<td>Student data</td>
</tr>
<tr>
<td>#2</td>
<td>Student data</td>
<td>Student data</td>
<td>Student data</td>
</tr>
<tr>
<td>#3</td>
<td>Student data</td>
<td>Student data</td>
<td>Student data</td>
</tr>
<tr>
<td>#4</td>
<td>Student data</td>
<td>Student data</td>
<td>Student data</td>
</tr>
</tbody>
</table>

6. a. Answers will vary.  
   b. Answers will vary.

### Activity 2

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description (Structure and/or Function)</th>
<th>Connections to Things I Have Already Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacrimal gland</td>
<td>Produces tears.</td>
<td>Exocrine gland—secretes its products onto a body surface.</td>
</tr>
<tr>
<td>Lacrimal canaliculi</td>
<td>Passageways for tears from lacrimal gland to lacrimal sac.</td>
<td>Canaliculi = “little canals”; are similar to canaliculi in compact bone, which house the cytoplasmic extensions of osteocytes.</td>
</tr>
<tr>
<td>Lacrimal sac</td>
<td>Collects tears</td>
<td>Sits in the lacrimal fossa of the skull.</td>
</tr>
<tr>
<td>Nasolacrimal duct</td>
<td>Receives tears from the lacrimal sac and drains them into the nasal cavity.</td>
<td>A duct releases substances onto internal or external body surfaces; also duct of sweat gland, pancreatic duct, salivary gland duct.</td>
</tr>
<tr>
<td>Palpebrae (eyelids)</td>
<td>Protect the eye; supported internally by connective tissue plates (tarsal plates).</td>
<td>Projecting from eyelids are eyelashes; richly innervated by root hair plexuses.</td>
</tr>
<tr>
<td>Medial and lateral commissures</td>
<td>Where superior and inferior eyelids meet medially and laterally.</td>
<td>Commissural tracts are bundles of nerve fibers in the CNS that connect the right and left cerebral hemispheres; the me-</td>
</tr>
</tbody>
</table>
dial and lateral commissures “connect” the upper and lower eyelids.

**Lacrimal caruncle**
- A raised area at the medial commissure; produces a whitish oily secretion.
- Contains glands that produce mucus that accumulates when we sleep.

**Conjunctiva**
- Thin mucous membrane lining the internal surface of the eyelids and the anterior surface of the eyeball.
- Can become inflamed = conjunctivitis (pink-eye)

**Conjunctival sac**
- Space between ocular conjunctive and palpebral conjunctiva.
- Where a contact “sits”

---

**Making Connections: Extrinsic Eye Muscles**

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Action</th>
<th>Connections to Things I Have Already Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior oblique</td>
<td>Elevates and moves eye laterally.</td>
<td>Oblique = muscle fibers run diagonally; innervated by CN III (oculomotor nerve).</td>
</tr>
<tr>
<td>Inferior rectus</td>
<td>Depresses eye.</td>
<td>Rectus = straight; innervated by CN III.</td>
</tr>
<tr>
<td>Medial rectus</td>
<td>Moves eye medially.</td>
<td>Innervated by CN III.</td>
</tr>
<tr>
<td>Lateral rectus</td>
<td>Moves eye laterally.</td>
<td>Innervated by CN VI.</td>
</tr>
<tr>
<td>Superior oblique</td>
<td>Depresses eye and moves it laterally.</td>
<td>Passes through the trochlea, a loop suspended from the frontal bone; innervated by CN IV (trochlear nerve).</td>
</tr>
<tr>
<td>Superior rectus</td>
<td>Elevates eye</td>
<td>Innervated by CN III.</td>
</tr>
</tbody>
</table>
# Making Connections: The Structure of the Eyeball

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description (Structure and/or Function)</th>
<th>Connections to Things I Have Already Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornea</td>
<td>Protects the eye.</td>
<td>“Window” of the eye; anterior one-sixth of the outer fibrous layer</td>
</tr>
<tr>
<td>Sclera</td>
<td>Protects eye and provides attachment site for extrinsic eye muscles.</td>
<td>Composed of tough fibrous connective tissue.</td>
</tr>
<tr>
<td>Choroid</td>
<td>Vascular tunic that supplies oxygen and nutrients to tissues of the eye.</td>
<td>Contains abundant melanocytes; melanin in melanocytes absorbs stray light; melanin is also produced by melanocytes in the epidermis.</td>
</tr>
<tr>
<td>Ciliary body</td>
<td>Produces aqueous humor; controls shape of lens.</td>
<td>Contains ciliary muscles that contract and pull on suspensory ligaments, which suspend the lens.</td>
</tr>
<tr>
<td>Iris</td>
<td>Regulates size of pupil.</td>
<td>Pupillary reflex is controlled by the ANS, which acts on smooth muscle of the iris to control the size of the pupil.</td>
</tr>
<tr>
<td>Retina</td>
<td>Inner neural layer containing rods and cones (photoreceptors)</td>
<td>Continuous with the optic nerve; contains macula lutea = yellow spot that contains a depression called the fovea centralis in which is found the highest concentration of cones and thus the sharpest vision in the retina.</td>
</tr>
<tr>
<td>Lens</td>
<td>Focuses light on retina.</td>
<td>Composed of anucleate cells packed with transparent proteins called crystallins; RBCs are also anucleate and are packed with hemoglobin for the transport of oxygen.</td>
</tr>
</tbody>
</table>
Anterior cavity

Located between the cornea and lens; divided into anterior and posterior chambers; filled with aqueous humor.

Divided into two chambers by the iris.

Posterior cavity

Located between the lens and filled with vitreous humor.

Contains vitreous humor produced before birth.

Optic nerve

Transmits visual signals from the eye to the thalamus and to the occipital lobe.

Continuous with retina; leaves eye at the optic disc (or “blind spot” because it lacks photoreceptors); optic nerves cross over to form the optic chiasma.

Activity 3

3. retina

4. List two functions of the cornea. __protection; allow light to enter eye__

List two functions of the sclera. __protection; attachment site for extrinsic eye muscles__

6. Lens: __biconcave structure that focuses light on retina__

Ciliary body: __thickened region of choroid coat; produces aqueous humor__

Iris: __colored portion of eye with pupil in the center__

Pupil: __opening through which light travels__

7. Vitreous humor: __jelly-like substance that fills posterior cavity__

Retina: __tissue-paper thin structure containing photoreceptors__

Optic disc: __point at which retina leaves the back of the eyeball__

Choroid: __middle vascular tunic that supplies oxygen and nutrients to eye tissues__

Tapetum lucidum: __iridescent blue pigment in choroid that reflects light__

How does the choroid in the cow eye differ from the choroid in the human eye?

_It contains tapetum lucidum. Human choroid is dark brown-black._
Activity 4

A. Demonstrating the Blind Spot
2. *When the dot is focused on the blind spot, which lacks photoreceptors, the dot disappears.*

B. Testing Visual Acuity
6. Visual acuity of: right eye without glasses: __student data__
   right eye with glasses: __student data__
   left eye without glasses: __student data__
   left eye with glasses: __student data__

7. *Individuals with 20/200 vision see at 20 feet what most other people see at 200 feet.*

C. Testing for Astigmatism
4. Based on this test, do you have astigmatism? __student data__
   How is astigmatism corrected? __with special lenses that compensate for the irregularities in the curvatures of the refracting surfaces__

D. Testing for Color Blindness
3. Number of females with normal color vision: __student data__
   Number of females who are color blind: __student data__
   Number of males with normal color vision: __student data__
   Number of males who are color blind: __student data__

4. Explain why color blindness is more common in males than in females. __It is an X-linked recessive trait__

E. Determining Near Point of Accommodation
4. Near point of accommodation of right eye: __student data__ cm
   Near point of accommodation of left eye: __student data__ cm
### Activity 5

1. 

<table>
<thead>
<tr>
<th>Ear Structure</th>
<th>Description (Structure and/or Function)</th>
<th>Connections to Things I Have Already Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auricle (pinna)</td>
<td><em>Directs sound waves toward external auditory canal.</em></td>
<td><em>Is largely composed of elastic cartilage; elastic fibers give it flexibility.</em></td>
</tr>
<tr>
<td>External auditory canal</td>
<td><em>Component of external ear; located within the temporal bone; is a passageway for sound waves.</em></td>
<td><em>Contains hairs and ceruminous glands to trap debris, insects, etc.</em></td>
</tr>
<tr>
<td>Tympanic membrane</td>
<td><em>Vibrates in response to sound waves entering the external auditory canal.</em></td>
<td><em>Skin on lateral surface; mucous membrane on medial surface; marks the beginning of the middle ear.</em></td>
</tr>
<tr>
<td>Auditory ossicles</td>
<td><em>Vibrate in response to vibrating tympanic membrane.</em></td>
<td><em>Three smallest bones in the body: malleus (hammer), incus (anvil), stapes (stirrup); names are based on the shapes of the bones.</em></td>
</tr>
<tr>
<td>Oval window</td>
<td><em>Vibrates in response to the vibrating stapes, causing the fluid in the inner ear to move.</em></td>
<td><em>Marks the lateral boundary of the inner ear.</em></td>
</tr>
<tr>
<td>Pharyngotympanic tube</td>
<td><em>Connects middle ear to nasopharynx; allows for equalization of pressure on either side of tympanic membrane.</em></td>
<td><em>Old names = Eustachian tube, auditory tube</em></td>
</tr>
<tr>
<td>Bony labyrinth</td>
<td><em>Outer, bony part of the inner ear; is filled with perilymph.</em></td>
<td><em>“Labyrinth” is synonymous with maze.</em></td>
</tr>
<tr>
<td>Membranous</td>
<td><em>Inner membranous part</em></td>
<td><em>Located within the bony lab-</em></td>
</tr>
<tr>
<td>Labyrinth</td>
<td>Inner ear; filled with endolymph.</td>
<td>Yrinth.</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Cochlea</td>
<td>Snail-shaped structure that contains the receptor organ for hearing—the spiral organ</td>
<td>Cochlear implants are used for sensorineural hearing loss.</td>
</tr>
<tr>
<td>Vestibule</td>
<td>Middle part of inner ear; subdivided into utricle and saccule, which contain macula (receptor organ for static equilibrium).</td>
<td>Vestibular nerve innervates the receptor organs of the vestibule and the semicircular canals.</td>
</tr>
<tr>
<td>Semicircular canals</td>
<td>Function in dynamic equilibrium.</td>
<td>Anterior, lateral, and posterior canals; each has a swelling at the base called the ampulla, which contains a crista ampullaris.</td>
</tr>
<tr>
<td>Vestibulocochlear nerve</td>
<td>Vestibular nerve and cochlear nerve join to form CN VIII (vestibulocochlear nerve).</td>
<td>CN VIII; passes through the internal acoustic meatus (passageway) of the temporal bone on its way to the thalamus.</td>
</tr>
</tbody>
</table>

2. Name the receptor organ in the cochlea, and describe its function. **Spiral organ**—movement of endolymph causes hair cells to rub against tectorial membrane generating a graded potential.

3. Name the receptor organs in the vestibule, and describe their function. **Maculae**—movement of endolymph causes hair cells to rub against otolithic membrane generating a graded potential.

4. Name the receptor organs in the semicircular canals, and describe their function. **Crista ampullaris**—movement of endolymph causes hair cells to rub against cupula generating a graded potential.
Activity 6

A. Performing the Weber Test

1. Can you tell by performing this test whether the unilateral deafness is conductive hearing loss or sensorineural hearing loss? Yes. Explain. In sensorineural deafness, the tone will be heard in the unaffected ear. In conduction deafness, the tone will be heard in the affected ear.

2. If an individual has unilateral conduction deafness, in which ear do you think the sound will be loudest: the normal ear or the deaf ear? deaf ear. Explain. The sound will be loudest due to sound conduction by the bones of the skull.

If an individual has unilateral sensorineural deafness, in which ear do you think the sound will be loudest: the normal ear or the deaf ear? normal ear. Explain. Sound waves are unable to stimulate the hair cells in the deaf ear or there is a problem with the cochlear nerve.

C. Performing the Romberg Test

1. Did the subject sway slightly or significantly? student data

4. Did the subject sway slightly more or considerably more than with eyes open? student data

5. Based on your observations, does vision play a role in maintaining equilibrium? Explain. Yes, swaying is more prominent when eyes are closed.

6. Predict how the results would have been affected if the subject has a damaged vestibular apparatus. greater amount of swaying
ANSWERS TO POST-LAB ASSIGNMENTS

PART I. Check Your Understanding

Activity 1: Exploring the Gross Anatomy of Olfactory and Gustatory Structures and Demonstrating the Effect of Olfaction on Gustation

1. The receptors for olfaction and gustation are classified as [chemoreceptors] because they respond to chemicals in an aqueous solution.

2. Name the cranial nerves that transmit sensory information from the taste buds to the gustatory cortex.
   a. **facial nerve (CN VII)**
   b. **glossopharyngeal nerve (CN IX)**
   c. **vagus nerve (CN X)**

3. What effects does olfaction have on a person’s ability to taste food? **Taste is dependent upon smell; nasal congestion causes food to taste bland. Both senses depend on chemoreception.**

Activity 2: Examining the Gross Anatomy of the Eye

1. Which three cranial nerves innervate the extrinsic eye muscles?
   **oculomotor n. (CN III), trochlear n. (CN IV), abducens (CN VI)**

2. Identify each labeled eye structure in the accompanying illustration. Then circle the components of the outer fibrous layer in green, the components of the middle vascular layer in red, and the structure that comprises the inner neural layer in yellow.
   a. **ciliary body**
   b. **suspensory ligaments**
   c. **iris**
   d. **lens**
   e. **pupil**
   f. **cornea**
   g. **blind spot**
   h. **optic nerve**
   i. **retina**
   j. **choroid**
   k. **sclera**
3. On the accompanying illustration:
   a. Color the anterior cavity blue. Which fluid fills it?
      *aqueous humor*
   b. Which structure produces this fluid?
      *ciliary body*
   c. What is the function of this fluid?
      *supplies oxygen and nutrients to lens and cornea*
   d. Which structure divides the anterior cavity into an anterior chamber and a posterior chamber? *iris*
   e. Color the posterior cavity orange. What substance fills it?
      *vitreous humor*
   f. What are two functions of this substance? *contributes to intraocular pressure and transmits light*
Activity 3: Dissecting the Mammalian Eye

1. Identify the labeled structures in the accompanying photographs of a dissected cow eye.
   a. **sclera**
   b. **cornea**
   c. **choroid**
   d. **vitreous humor**
   e. **lens**

![Dissected Cow Eye Image]

Activity 4: Performing Visual Tests

1. Where specifically is the blind spot located? **where optic nerve exits the eye**
2. What does 20/100 vision mean? **An individual sees at 20 feet what the average person sees at 200 feet.**
3. Define astigmatism. **A condition in which an irregular curvature of the cornea or lens prevents light rays from being focused properly on the retina**
4. What causes color blindness? **the absence of one or more cone types**
5. Why does an individual’s near point of accommodation decrease as he or she ages? **The elasticity of the lens decreases with age, making it difficult to focus for near vision**

Activity 5: Examining the Gross Anatomy of the Ear

1. Identify each of the structures of the ear shown in the accompanying illustration.
   a. **vestibule**
   b. **vestibular nerve**
c. cochlea nerve
d. cochlea
e. semicircular canal
f. stapes
g. incus
h. malleus
i. tympanic membrane

Activity 6: Performing Hearing and Equilibrium Tests

1. List two possible causes of conduction deafness. __damage to tympanic membrane; damage to ossicles__

2. List two possible causes of sensorineural deafness. __damage to hair cells of the cochlea; damage to the optic nerve__

3. What was the purpose of placing a cotton ball in the subject’s external auditory canal during the Weber test and the Rinne test? __to mimic unilateral conduction deafness__
PART II. Putting It All Together

A. Review Questions

Answer the following questions using your lecture notes, your textbook, and your lab notes.

1. What are the functions of the gustatory hairs that project from a taste pore? *They respond to chemicals in solution, leading to depolarization of the hair cells.*

2. Why is it impossible for a contact lens to get “lost” behind the eyeball? *It sits in the blind-ended conjunctival sac.*

3. List (in order) the eye structures (internal structures, fluids, and retinal layers) through which light travels from the point at which it enters the eye until it reaches the photoreceptors in the retina. *cornea, aqueous humor, lens, vitreous humor, ganglion cells, bipolar cells, photoreceptors*

4. A retinal detachment occurs when the retina separates from the choroid. Why is this condition considered to be a medical emergency? *If the retina is not in contact with the choroid, it will not receive oxygen and nutrients and the cells will die.*

5. Why can the inner ear be described as a “tube within a tube”? *The membranous labyrinth follows the contours of the bony labyrinth.*

6. Melanocytes in both the choroid and the cells of the pigmented epithelium contain melanin. How is this pigment important to eye function? *It absorbs stray light and prevents it from reflecting within the eye.*

7. Name another location of melanocytes, and describe their function at that site. *Epidermis of skin; protect skin cells from UV light*

B. Concept Mapping

1. Fill in the blanks to complete this concept map outlining the anatomy of the eye.

   Choroid  ciliary body  cornea  retina  vascular
2. Construct a unit concept map to show the relationships among the following set of terms. Include all of the terms in your diagram. Your instructor may choose to assign additional terms.

<table>
<thead>
<tr>
<th>aque-</th>
<th>cere-</th>
<th>foramina</th>
<th>incus</th>
<th>malleus</th>
</tr>
</thead>
<tbody>
<tr>
<td>ous humor</td>
<td>bral cortex</td>
<td>neural</td>
<td>optic nerve</td>
<td>photoreceptor</td>
</tr>
<tr>
<td>mechanore-</td>
<td></td>
<td></td>
<td></td>
<td>rod</td>
</tr>
<tr>
<td>ceptor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>taste bud</td>
<td>thalamus</td>
<td>utricle</td>
<td>vascular</td>
<td>vestibulo-cochlear nerve</td>
</tr>
</tbody>
</table>

Answers will vary.