Mammalian Eye Dissection
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What are the structures of the mammalian eye and how do they function?

The goal of this laboratory activity is to identify and understand the structures of the mammalian eye and their functions. The structures of the eye form an image which lead to the generation of action potentials on the axons of the optic nerve. This nerve activity is interpreted by the brain, resulting in visual perception. The cow eye is very similar to, but larger than, the human eye. Some differences will be noted in the instructions below.

Materials
- Safety goggles
- Gloves
- Lab apron
- Dissection trays
- Clamps (2 pair: straight and curved)
- Scissors
- Probe
- Cow eye

Internal features of the eye

A. Locate the cornea, sclera, and optic nerve.
   a. The white part of the eye, the sclera, is a tough, outer covering of the eyeball. The sclera gives the eye its shape and helps to protect the delicate inner parts.
   b. The covering over the front of the eye is the cornea. When the cow was alive, the cornea was clear. The cornea may be cloudy or bluish in your specimen. Together with the lens, the cornea refracts light to bring the light to a focus on the retina. The cornea gives a larger contribution to the total refraction than the lens. The curvature of the cornea is fixed while that of the lens is changeable.
   c. You may be able to look through the cornea and see the iris, the colored part of the eye, and the pupil, the dark oval in the middle of the iris.
   d. At the back of the eye is the optic nerve (CN III), which transmits visual information to the brain. To see the fascicles that make up the nerve, pinch the nerve with a pair of scissors or your fingers. Each fascicle contains many axons. If you squeeze the optic nerve, you may extrude some white viscous material. That is myelin, the layer of lipid, protein, and glycolipid that surrounds each axon in the nerve.

B. Examine the fat and muscle surrounding the eyeball.
   a. Like humans, cows have six extracocular muscles (1), although at least one source says they have only four (2). Locate muscles in your specimen. The specimen eye you have probably includes accessory muscles near the eye such as levator palpebrae and orbicularis oculi. Before you begin your dissection, locate muscles in your specimen. Can you tell if they attached to the globe of the eye? If yes, they are the extracocular muscles. If not, they are accessory muscles such as levator palpebrae or orbicularis oculi.
   b. The right and left eyes see the world from different vantage points. Ocular dominance refers to the fact that the brain gives greater weight to the input from one of the two eyes. Use the following procedure to determine your dominant eye: Form a circle with your thumb and index finger, at arm’s length. With both eyes open, look at a distant object (such as a point on the far wall of the room) through the circle. Without moving your arm and hand, close and open one eye, and then the other. The eye which sees the object through the circle is your dominant eye.
c. Yellow fat surrounding the eyeball provides cushioning between the eyeball and the bony orbit. Portions of cranial and facial bones make up the orbit.

C. Carefully dissect away the fat, connective tissue, and accessory muscles around the eyeball. Place removed tissue in the other tray. Preserve the optic nerve and the extraocular muscles.

D. Cut the eye in half

Use the photos to help you.

a. Use a scalpel with a sawing motion to make a small incision in the sclera at the “equator” of the eye. Stabilize the eye on the wax-filled dissection tray as you do this, and be careful not to cut yourself! Clear liquid, a mix of aqueous and vitreous humor, will emerge when the cut penetrates the globe.

b. If you detect a semisolid vitreous humor in the eye, cut through it with the scalpel, in the same plane as the cut of the wall of the globe. This will allow the vitreous humor and lens to remain in the natural position during the next step.

c. Use your scissors or scalpel to continue the cut around the middle of the eye, cutting the eye into anterior and posterior portions of equal size. The anterior portion will include the cornea. It will also include the lens, unless the lens has come out with the vitreous humor or has disintegrated with freezing and thawing. Keep the anterior segment “pointed down” on the wax tray, to contain the lens and vitreous humor.

d. The cornea is made of tough transparent connective tissue. It allows light to enter the eye, bends the light, and provides protection for interior structures.

E. Remove the lens

a. Read instructions a and b before removing the lens. The lens is a clear lump about the size and shape of a squashed marble. The lens and cornea refract light and bring the incoming light to a focus on the retina.

b. Try to identify the ring-shaped ciliary muscle and the suspensory ligaments, also known as the ciliary zonule. The ciliary muscle, zonule, and fluid-secreting structures comprise the ciliary body. The ciliary body is located posterior to the iris and surround the lens. The zonular fibers appear as thin dark strands. Contraction of the ciliary muscle changes the curvature of the lens and therefore alters the focal distance of the eye.

c. Locate the lens. It may have fallen out with the vitreous humor when you cut the eye in half, or it may still be in the anterior portion of the hemisected eye. If it is in the eye, lift it out. Handle it gently since it is easily squashed.

d. The lens feels soft on the outside and hard in the middle. Hold the lens up and look through it. In a living organism, it is transparent. Your cow lens may not be transparent. To focus on closer objects, it gets “rounder” (more like a sphere, less like a pancake). The more spherical lens shape allows it to bend light more strongly, which is necessary to form an image of a close object.

e. Put the lens down on this document and look through it at the printed words. If your lens is transparent, it will magnify.
F. Remove the iris and cut through the cornea

a. The iris is anterior to the now-absent-lens, and posterior to the cornea. Put the tip of the blunt probe gently between the iris and the cornea. Move it around to explore the 360 degree attachment of the iris to the outer edge of the cornea. Try to determine the shape of the pupil, the opening in the center of the pupil.

b. Find the iris and pull it out. It should come out in one piece.

c. Note the pupillary opening in the removed iris. The iris contracts in bright light and dilates in dim light.

d. With the anterior portion of the eye front-side-down on the wax tray, cut through the cornea with the scalpel. You may hear a crunch as you incise the cornea, as the scalpel cuts through layers of protein. The cornea’s multiple layers enhance its strength and protective ability.

F. Examine the retina

a. If the vitreous humor is still in the posterior portion of eyeball, empty it out.

b. On the inside of the posterior portion, note blood vessels. They are just behind the innermost layer of the eye, the retina. In the living animal. The retina was flat on the posterior wall of the eye. It may be loosely attached now, and may contain folds. These folds were not present in life.

c. The retina is made of photoreceptors (rods and cones) and neurons that do the initial stages of visual information processing. The cornea and the lens focus the light that comes into the eye, to make an image on the retina. The photoreceptor cells of the retina experience voltage changes when light hits them. These voltage changes cause changes in neurotransmitter release which cause action potentials in ganglion cells of the retina. Ganglion cell axons travel along the inner surface of the retina to the optic disk, and continue out of the eyeball. In humans, each optic nerve contains 0.8 to 1.7 million axons.

d. Use your finger to push the retina around. The retina is attached to the back of the eye at just one spot. Find that spot. That is the optic disc, where axons from all the retinal ganglion cells come together. All the axons go out the back of the eye, forming the optic nerve, carrying visual information from the eye to the brain.

e. The optic disc is also called the blind spot. Because there are no photoreceptors at that spot, an object in the visual field that projects onto the blind spot will not be seen.

G. Notice the tapetum lucidum

Under the retina, the back of the eye is covered with shiny, blue-green stuff. This is the tapetum lucidum. It reflects light from the back of the eye. Cats, dogs, cows, and many other animals have a tapetum lucidum. When caught in the headlights at night, a cat’s eyes seem to glow, or reflect brightly, because the cat’s tapetum is reflecting light. If you shine a light at a cow at night, the cow’s eyes will shine with a blue-green light because the light reflects from the tapetum. The tapetum improves night vision by reflecting light back to the photoreceptors, but it degrades image quality and therefore reduces visual acuity. Most primates, including humans, do not have a tapetum lucidum. O.C. Bradley wrote of ruminants (such as cows) that “The Tapetum Lucidum is golden green in colour with a blue periphery.” What color or colors do you observe in your specimen?

H. Find your blind spot

Use the two dots below to find your blind spot. Close or cover your left eye and fixate on the left-hand dot, with your eyes about 18 inches from the page or screen. At first, you will see the right hand dot in your
peripheral vision. As you slowly move closer to the page, the right-hand dot disappears from view. If you shift your gaze while keeping your head fixed, the right dot will reappear, but when you focus on the left dot, the right dot will be invisible. Move your head closer and the missing dot reappears. You’ve found your blind spot!

If the right hand dot never disappears, or only partially disappears, repeat the test with your head slightly tilted one way or the other.

Repeat with the right eye closed, focusing on the right hand dot, to find the blind spot in your left eye.

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I. Clean Up

a. Carefully dispose of scalpel blade in sharps container.
b. Place all tissues in a red biohazard bag in a biohazardous waste box.
c. Wash instruments and trays using hot water and soap.
d. Do not nest wax-containing trays, since doing so causes wax to stick to the back of the tray on top.
e. Clean your work area with paper towel and soap and water.

J. Lab Report

Submit your answers to the Cow Eye Dissection Questions to your teaching assistant. Your TA will specify if they prefer electronic or hard copy or either. Submit one set of answers per lab group.

References


