

McPherson Eye Research Institute Bovine Eye Dissection Guide
(Tom Yin, January 2025)

Objectives¹:

- Students should learn the gross anatomy of the eye and be able to identify the structures and functions of its parts.
- Following the instructions on the “Why do we have a blind spot?” sheet, students should be able to locate the blind spot in each eye and explain why it exists.
- Students should see and understand the relationship between the optic nerve on the gross eyeball and the blind spot.
- Students should learn that the lens, though colorless and transparent, is made of cells.

Dissecting materials for two classes at a time:

Small, handled cooler containing ice/icepack and eyeballs (1 for every 5 students)
10 sharp scissors
10 single-edge razor blades
10 dissection trays (if needed)
20 disposable petri dish halves, 50 X 15mm (= 10 complete dishes); 2 halves/tray
10 copies of the **Quick Guide - Cow Eye Dissection** (last page of these instructions)
A few spare safety glasses for demonstrators
Two 3-D models of the eye
At least 200 disposable gloves for the day
(teacher-run copies of) “Why do we have a blind spot” sheet, 1/student
(teacher-projected) “Why do we have a blind spot” file
(teacher-projected) Image of an H&E-stained thin section of a dog’s lens file

Procedures:

1. Set the trays, eyeballs and equipment away from the students — either on the demonstration bench or by the sink.
2. MERI demonstrators wear gloves on both hands, and safety glasses.
3. Teacher projects the “Why do we have a blind spot?” sheet on their display screen.
4. Hand out the “Why do we have a blind spot?” sheet and 1 glove per student
5. Engage the students:
 - a. Introduce yourself and MERI. This creates a connection with the students that enhances their ability to learn from us.
 - b. Explain that this material comes from animals that were alive just a few days ago and that we need to treat it with respect. We expect them to treat the material with respect for those animals and for the organ itself. Emphasizing **respect** for the material invariably sets a tone that extends to respect for the presenters.
6. Using the diagram on the blind spot sheet and the 3-D model, REVIEW the parts of the eye that students will see in the dissection and the path of light to the retina.
7. Do the Blind Spot activity here. Most people are not aware that they have a natural blind spot in each eye, but everyone should be able to demonstrate the blind spot when tested in this manner. If they have trouble seeing the blind spot, they should try moving the paper SLOWLY at different distances. With one eye closed and looking at the “X”, at some critical distance the white spot should disappear. The critical test is that when they close the opposite eye, the other spot should disappear. Where is the blind spot

on the retina, near the nose or near the temple? Ans: When the left eye is closed, the spot on the right disappears. Therefore, in the seeing right eye, the blind spot is on the nasal side of the fovea or center of vision. The blind spot is on the nasal side of the center of vision in the left eye, as well.

8. Offer an alternative activity for students who object to the dissection
 - a. student turns back to the dissection, but is required to listen
 - b. teacher sends the student from the room with their Chromebook to view (the excellent) <https://www.exploratorium.edu/video/cows-eye-dissection>
9. Dissection -- Demonstrator
 - a. Place dissecting trays with tools and eyeball in the center of grouped tables.
 - b. Identify external anatomy: cornea, sclera, (actually 7, but we're happy to find 4) muscles, fat, optic nerve at the back of the eyeball
 - c. Use scalpel/single edge razor to cut off the eye cup, just below the cornea, and show cornea, iris, (rectangular!) pupil shape. Fluid (aqueous humor) will squirt out when you pierce the cornea. The sclera, which is the outer membrane of the cornea, is very tough and can be difficult to cut. It's often easier to poke a hole with a sharp scalpel blade or razor and then use scissors to cut around the circumference of the eyeball. This cut should be at the edge of the cornea while cupping the eyeball with one hand and cutting with the other. Keep the eyeball facing upward while you cut much in the way you open the top of a soft-boiled egg without spilling the yolk. Transfer the cornea and iris to the petri dish but keep the eyeball in your hand with the cut end up.

Ideally, the lens is still resting atop the vitreous, held in place by a ring of ciliary muscles. Students can look down into the vitreous and see the back of the eye. Remove the lens and place it on the petri dish. Place this dish atop the Blind Spot handout, demonstrating the lens' magnification. Pass the dish around and invite students to touch the lens with a gloved finger.
 - d. Either during the review (6), or during the dissection, display the photomicrograph of an H&E-stained thin section of a (dog) lens, showing that it is made of many cells. [The outer layer at the top of the image is the lens capsule. Just below the lens capsule are nucleated lens epithelial cells with prominent nuclei. These cells secrete the capsule, which is made of protein. The lens epithelial cells divide and migrate to the nuclear bow where they rotate and elongate to form long lens fibers that extend from the front of the lens to the back.] The newly formed lens fibers contain nuclei, which are visible in some of the cells in this image. But as the lens fibers mature, they lose their nuclei. The normal lens, made of millions of cells, is still transparent!
 - e. Ideally the viscous, jelly-like, vitreous humor is still in the eyeball. Have the students look down into the eyeball to see the blood vessels in the back of the eye while you are holding it in your hand. Pour the vitreous into the petri dish noting its transparency and high viscosity. Invite students to touch the vitreous with their gloved finger. What is the role of the vitreous and why is it more viscous than the aqueous humor? Ans: the vitreous is important to

keep the eyeball round (or 'inflated') and to keep the retina pressed against the back of the eyeball. Defects in this function can cause a detached retina and loss of vision.

- f. Ideally, the retina is lying in a smooth layer lining the entire back of the eye. Note the tiny blood vessels running through it. Mammals are the only class of animals to have blood vessels in the retina! What are the advantages and disadvantages to having blood vessels in the retina? Ans: blood vessels provide nutrition to the retina, but block vision by their presence. With a probe slowly detach the retina by lifting an edge to show how thin it is. Keep pushing the retina loose from the back of the eyeball and look for the point where the axons of the retinal ganglion cells remain attached to the back of the eye. This is the blind spot. Where the axons exit the eye there are no photoreceptors (rods and cones), so there is no way to detect light at this spot (see bottom diagram on Blind Spot sheet). To show that the retina is attached to the optic nerve head, invert the eye cup so the retina dangles. It's held in the eye cup where the axons from the ganglion cells form the optic nerve. Show again how the point of attachment is continuous with the optic nerve protruding from the back of the eye.
- g. Point to the tapetum, a reflective layer behind the retina in many nocturnal and crepuscular animals, including the cow. Ask students to describe it. Is the coloration uniform? Which side is the tapetum on? Ans: On the dorsal (upper) side of the eyeball.
- h. Encourage the students to take the Blind Spot sheet home to show their parents when they ask them what they learned in school today. Their parents are probably not aware that they have a natural blind spot in both eyes, so this is an opportunity for the children to educate the parents. Do not give lenses or other eye parts to the students to take home, due to lingering concerns about Mad Cow (Bovine spongiform encephalopathy) disease (According to the CDC, the most recent case in the US was in May 2023. It was only the seventh confirmed cases of the deadly disease ever recorded in the USA.)
- i. Clean materials for the next class and before leaving, dispose eyeball waste in a designated trash can.

¹**Wisconsin Standards for Science** for grades 6-8 (2017) addressed in this activity,
where LS = Life Science:

SCI.LS1.A Structure and Function:

SCI.LS1.A.m All living things are made of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.

SCI.LS1.D.m Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain resulting in immediate behavior or memories.

Example Three-dimensional Performance Indicator:

MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Quick Guide to the Cow Eye Dissection by Anna Shen, 2024

Each student can have one glove if they want to touch. Things to touch during the demo – external anatomy, optic nerve, vitreous, lens, blind spot, tapetum, cornea, iris.

1. Identify external anatomy Touch
 - a. Cornea, sclera, (7) muscles, fat, optic nerve (blind spot), pupil (rectangular). Trim excess fat if necessary.
2. Cut and separate parts of the eye.
 - a. Lay eye on tray and stabilize the eyeball by grasping the fat. Poke a hole about 1/8" behind cornea; use scissors to cut around the cornea, cornea should face upwards.
 - b. Cornea/iris in one dish; lens/vitreous in one dish; retina/tapetum/sclera in tray. Ideally, the lens is still resting atop the vitreous, held in place by a ring of ciliary muscles.
3. Lens/vitreous
 - a. Note the transparency of lens and vitreous. Touch
 - b. Transfer the lens to the small petri dish. Cut the ciliary muscles if necessary.
 - c. Place this dish atop the Blind Spot handout, demonstrating the lens' transparency, magnification, image reversal. Touch
4. Retina/tapetum/optic nerve.
 - a. Ideally, the retina is lying in a smooth layer lining the back of the eye. See color, tiny blood vessels, thinness, attachment to optic nerve. The blind spot is where the optic nerve is attached. Touch Show students the optic nerve protruding from the back of the eye again.
 - b. Point to the tapetum, a reflective layer behind the retina in many nocturnal and crepuscular animals, including the cow.
5. Cornea/iris – cut iris away from cornea. Touch
6. Other things to do –
 - photomicrograph of an H&E-stained thin section of the lens, regular arrangement of lens epithelial cells. Why is the lens transparent? Ans: no nuclei and other organelle, regular arrangement of cells, and the crystallin proteins are packed together to minimize light scattering.
 - repeat the Blind Spot activity
 - eye diseases and how to take care of your eyes
 - mouse eyes (small eye, big cornea, big lens).