

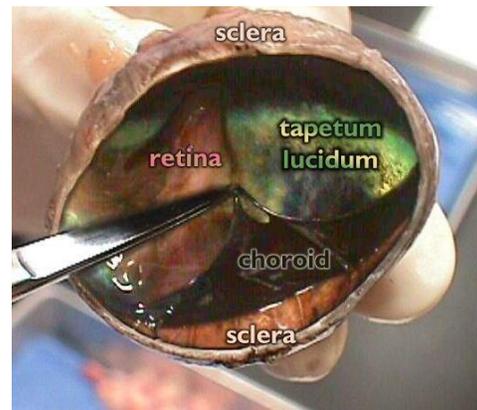
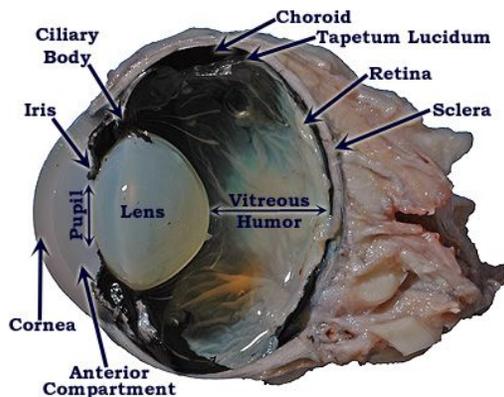
## Analysis of Visual Function (Gross Anatomy lab)

### **Objective:**

Introduce students to the concept of visual perception by way of optical illusion and gross anatomy. The first section of this course will focus on dissecting the cow eye while introducing two optical illusions that illustrate functional/structural aspects of the retina: the blind spot test (optic disk) and the blue field entoptic effect (retinal vasculature).

The second section of this course will focus on dissecting a sheep brain. During the dissection we will focus our attention on the optic chiasm, lateral geniculate nucleus, and visual cortex while introducing concepts such as visual cross-over, stereoscopic/binocular vision (framing game), motion detection (motion after effect) and other brain structures: sulci, gyri, hippocampus, and the corpus callosum.

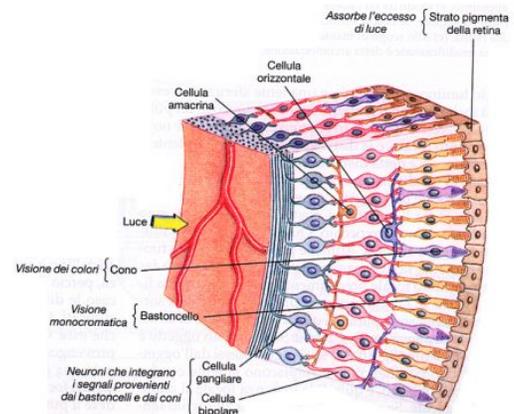
### **Session 1) Cow Eye Dissection**



### **Background**

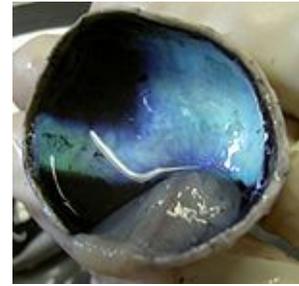
#### **Retina**

Light sensitive 0.5mm thick tissue lining the back of the eye. Light striking the retina initiates a cascade of electrochemical events that trigger electrical impulses in retinal ganglion cells. These signals travel down axon fibers in the retina and down the optic nerve into the brain. Photoreceptors (rods and cones) line the entire retina except at the optic disk (convergence of RGC axons into the optic nerve) resulting in a blind spot. The fovea (high concentrations of photoreceptors) is located at the center of the retina. The ora serrata defines the edges of the retina.



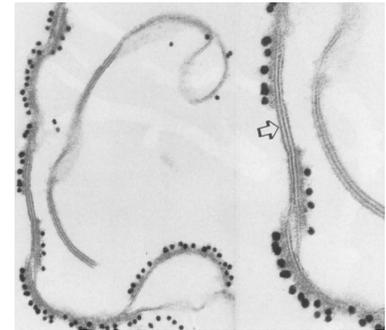
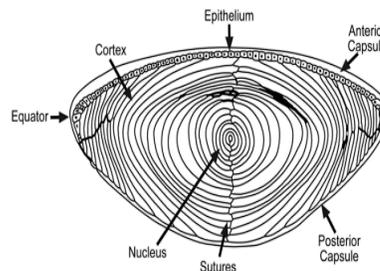
### Tapetum lucidum:

("bright tapestry") a layer of bright tissue immediately behind the retina found in many carnivorous nocturnal vertebrates (not humans). It reflects light back onto photoreceptors increasing the amount of light available to photoreceptors. "Eyeshine" in photographed animals is caused by light reflecting off the tapetum lucidum.



### Lens:

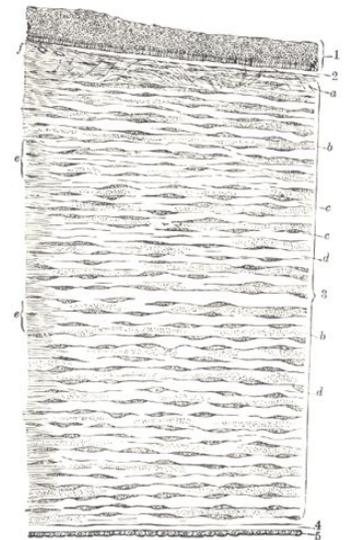
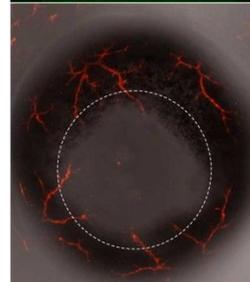
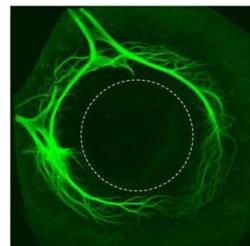
A biconvex glass like organ that focuses light onto the retina. The lens is composed a vast network of diverse proteins, plasma membrane, and gap junctions. The lens has three primary components: the capsule, the epithelium and lens fibers. The major protein



found within the the lens are transparent crystallin heat shock proteins. Hereditary cataracts, a disease of the the lens, is caused by mutations in the genes that encode alpha A and B crystallin proteins. Mutation results in the alpha crystallin's inability to prevent protein aggregation on the lens resulting in a reduction in transparency. There is no turnover in crystallin (proteins at the center of the eye were formed during embryogenesis) and age is associated with crystalline degradation.

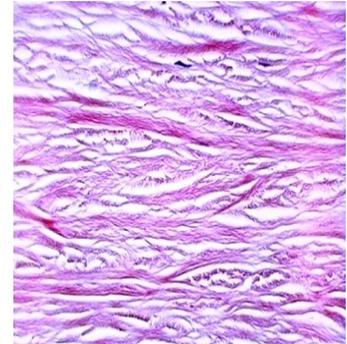
### Cornea:

The first defense against eye injury. The cornea is an innervated, avascularized, 5-6 layered structure (primates) composed of epithelium, collagen fibers, and cuboidal cells. The cornea is heavily innervated (300-600x greater than skin) with sensory nerve fibers emanating from the trigeminal nerve which can detect touch, temperature and chemicals. Stimulation results in the involuntary corneal reflex (blink reflex). Because the cornea is avascular, oxygen is acquired from dissolved oxygen in tears while nutrients are acquired from the aqueous humor.



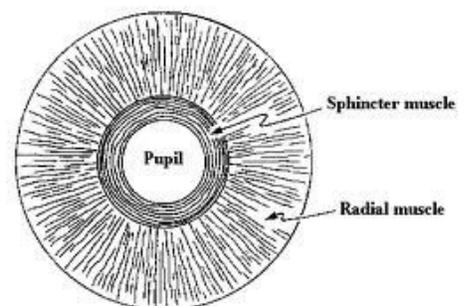
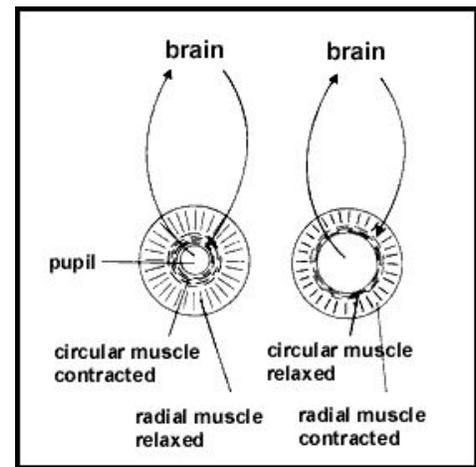
### Sclera:

White of the Eye. The opaque, highly vascularized (red eye) protective outer layer of the eye. The sclera is composed primarily of collagen, elastic fibers, and proteoglycans. The sclera serves to maintain the shape of the globe (eye) as well as provide attachment points for extraocular muscles. The sclera is continuous with the cornea. The opacity of the sclera is due to the irregular arrangement of type 1 collagen fibers as opposed to the nearly uniform arrangement of collagen fibers in the cornea.



### Iris:

The iris functions as the diaphragm (aperture stop) of the eye controlling the size and diameter of the pupil thereby limiting the amount of light entering the eye. The iris is composed of two layers: the stroma and beneath it a layer of pigmented epithelial cells. The stroma connects to two sets of muscles: sphincter muscles which contract the pupil in a circular motion and dilator muscles which pull the iris radially and enlarge the pupil. The composition of melanin pigment proteins in the iris determines its color. There are three types of a melanin in the human iris: black melanin, brown melanin, and reddish-yellow pheomelanin. Neuromelanin, which is found only in the brain, gives the substantia nigra and locus coeruleus its dark color.



### Choroid

Vascularized connective tissue lying between the retina and sclera. The choroid provides oxygen and nutrients to the outer layer of the retina. Melanin pigments the choroid and functions to limit uncontrolled reflection within the eye. Photographic red eye effect in humans is produced by uncontrolled light reflection from choroid. The



presence of melanin limits the amount of red eye seen in photographs. Odd-eyed cats are cats with heterochromia: one eye is blue while the other is green/yellow/brown. This is due a development defect in which one eye (blue eye) fails to form melanin. As a result, the blue is capable of producing both eye shine and red eye.

### **Ciliary Body**

Ring shaped tissue composed of ciliary muscle, blood vessels, epithelium, and fibrous connective tissue that divides the posterior chamber from the vitreous body and holds the lens in place. The ciliary muscle controls the shape of the lens altering the focus of the light on the retina while ciliary epithelium produces aqueous humor for the posterior chamber and vitreous body. The aqueous humor provides oxygen, nutrients, and metabolic waste removal to the lens and cornea. The production and reabsorption of aqueous humor contributes to intraocular pressure. Increased intraocular pressure is associated with glaucoma, a neurodegenerative disorder affecting the optic nerve.

### **Vitreous humor/body**

Transparent, colorless, gelatinous mass composed of phagocytes and water. Vitreous humor is produced by the ciliary body and localized to the vitreous body.

### **Evolution and behavior:**

“The cooperative eye theory”.

Compared to non-human primates, the human eye has smaller iris and a white sclera. It is hypothesized that this serves as a means of nonverbal communication allowing for other’s to detect the gaze of an individual and derive meaning from it. Behavioral studies also indicate that human infants follow the gaze of an experimenter by following her/his eyes. Apes on the other hand are more likely to follow a gaze by following the experiment’s head movement.

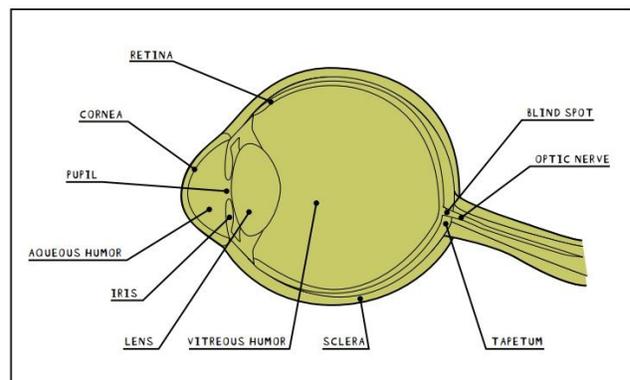


### **Cow eye dissection guide:**

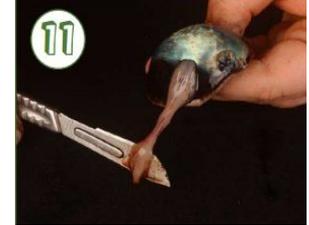
Adapted from: [http://www.exploratorium.edu/learning\\_studio/cow\\_eye/coweye.pdf](http://www.exploratorium.edu/learning_studio/cow_eye/coweye.pdf):

### **Supplies**

- one cow eye
- single edged razor blade or scalpel
- scissors
- forceps
- cutting cutting tray
- latex gloves
- soap,water, paper towels



1. Identify all outer structures of the eye: sclera, cornea, iris, pupil, iris, surrounding fat and muscle tissue.
2. With your scissors, cut away fat and muscle with
3. use the scalpel to make an incision in the cornea releasing the aqueous humor
4. Use the scalpel to make an incision through the sclera in the middle of the eye.
5. use your scissors to cut around the middle of the eye, cutting the eye in half. Two halves will be produced. The front half will contain the cornea and the back half will contain the optic nerve. Attempt to cut through the cornea to demonstrate its durability
6. With your fingers, pull out the iris. It is located between the cornea and the lens. It should come out in one piece. Identify the pupil and the sphincter and dilator muscles.
7. Identify vitreous humor on the back of the eye and remove the lens
8. Identify lens
9. Place lens on news paper and observe its ability to magnify words
10. On the back of the eye, identify the retina. With your forceps manipulate the retina and identify the optic disk (blind spot). Present blind spot optical illusion.
11. Cut the retina away from the choroid at the base of the optic disk.
12. Identify the tapetum and choroid. Attempt to dissect away choroid and tapetum.
13. Identify optic nerve



**Test for optic disk in visual field**

