# Experiment: 9

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**Semester: 8th** **Date of Performance: Apri 28, 2021**
**Subject Name: AR Lab** **Subject Code: CSF- 484**

## 1. Aim/Overview of the practical:

Structure of the human eye; Cameras; Photoreceptors

## 2. Task to be done:

Discuss the Structure of the human eye, the relationship of the human eye with the camera, and Photoreceptors. In Addition, implement as well as write down the steps of working of the human eye, Cameras, and Photoreceptors in augmented reality.

## 3. Theory:

**Structure of Human Eye:**

1. The Orbit: The eye is protected from mechanical injury by being enclosed in a socket, or orbit, which is made up of portions of several of the bones of the skull to form a four-sided pyramid, the apex of which points back into the head.

2. The Eyelids: It is vitally important that the front surface of the eyeball, the cornea, remain moist. This is achieved by the eyelids, which during waking hours sweep the secretions of the lacrimal apparatus and other glands over the surface at regular intervals and which during sleep cover the eyes and prevent evaporation.

3. Cornea: The cornea is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. Along with the anterior chamber and lens, the cornea refracts light, accounting for approximately two-thirds of the eye's total optical power.

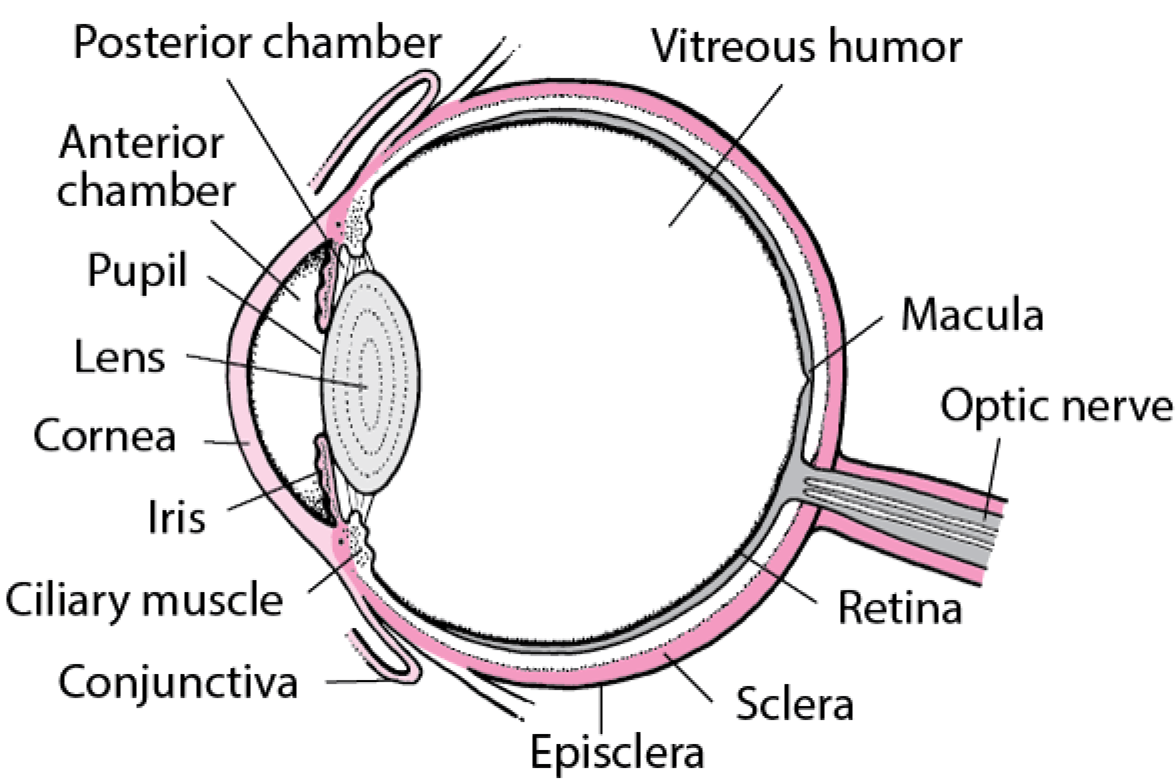
4. Pupil: The pupil is a black hole located in the centre of the iris of the eye that allows light to strike the retina. It appears black because light rays entering the pupil are either absorbed by the tissues inside the eye directly or absorbed after diffuse reflections within the eye that mostly miss exiting the narrow pupil.

5. Iris: The iris is a thin, annular structure in the eye, responsible for controlling the diameter and size of the pupil, thus the amount of light reaching the retina.

6. Lens: A nearly transparent biconvex structure suspended behind the iris of the eye, the sole function of which is to focus light rays onto the retina.

7. Retina: The retina is a thin layer of tissue that lines the back of the eye on the inside. It is located near the optic nerve. The purpose of the retina is to receive light that the lens has focused, convert the light into neural signals, and send these signals to the brain for visual recognition.

8. Optic Nerve: The optic nerve is a bundle of more than 1 million nerve fibres that carry visual messages. You have one connecting the back of each eye (your retina) to your brain. Damage to an optic nerve can cause vision loss.



**Relationship of the Human Eye with the Camera:**

Between the human eye, which produces pictures, and the camera, there are several similarities.

The light from the object must be focused on a light-detecting surface in order to create a clear picture of an object. In the human eye, the cornea and oculus perform this role. The lens works the same in the cameras. The distance in the human eye between the lens and the retina is constant. For this purpose, the lens changes shape thanks to the muscles as the distance of an object changes, in order to produce a clear picture. When the muscles are relaxed, the lens is flatter, and its sphericity increases when it contracts. Thus, the degree of refraction of light varies.

In cameras, the lens can collect at its focal point the image of a particular area of the subject. The angle that shows the part of this region created by the lens that falls on the plane or sensor of the film is called the angle of view of the lens. The higher the focal length, the smaller the viewing angle. The cameras create a frame at a certain angle according to the lenses they use. The field that each lens sees from the same distance when looking at the same object varies with the focal length.

**Photoreceptors:**
A photoreceptor cell is a specialized type of neuroepithelial cell found in the retina that is capable of visual phototransduction. The great biological importance of photoreceptors is that they convert light (visible electromagnetic radiation) into signals that can stimulate biological processes.

1. Light microscopy and ultrastructure of rods and cones
In vertical sections of the retina prepared for light microscopy with the rods and cones nicely aligned, the rods and cones can be distinguished rather easily.
Cones are robust conical-shaped structures with cell bodies situated in a single row just below the outer limiting membrane (OLM) and with inner and outer segments protruding into the subretinal space towards the pigment epithelium. In the foveal retina, where only cones are concentrated, their cell bodies are layered in oblique columns below the outer limiting membrane. Rods, on the other hand, are slim rod-shaped structures with their inner and outer segments filling the area between the larger cones in the subretinal space and stretching to the pigment epithelium cells. Rod cell bodies make up the remainder of the outer nuclear layer below the cone cell bodies. Apical processes from the pigment epithelium envelop the outer segments of both rods and
The higher magnification afforded by the electron microscope allows better resolution of rod and cone photoreceptors.

2. Outer segment generation
It is from the base of the cilium that membrane evaginations and invaginations occur to produce the outer segment (o.s.) or the important visual pigment-bearing portion of the photoreceptor. Outer segments of both the rods and cones arise from an outpouching of the photoreceptor cell plasma membrane at this point.

3. Visual pigments and visual transduction
Vertebrate photoreceptors can respond to light by virtue of their containing a visual pigment embedded in the bilipid membranous discs that make up the outer segment. The visual pigment consists of a protein called opsin and a chromophore derived from vitamin A known as retinal. Vitamin A is manufactured from beta-carotene in the food we eat, and the protein is manufactured in the phPupilotoreceptor cell (see above). The opsin and the chromophore are bound together and lie buried in the membranes of the outer segment discs.

4. Phagocytosis of outer segments by pigment epithelium
The stacks of discs containing visual pigment molecules in the outer segments of the photoreceptors are constantly renewed. New discs are added at the base of the outer segment at the cilium as discussed above. At the same time, old discs are displaced up the outer segment and are pinched off at the tips and engulfed by the apical processes of the pigment epithelium. These discarded, spent discs become known as phagosomes in the pigment epithelial cells. They are then broken down by lysis. Photoreceptor outer segment discs are phagocytosed by the pigment epithelium in a diurnal cycle.

5. Different types of cone photoreceptor
As we have seen from the morphological appearances described above, two basic types of photoreceptors, rods and cones, exist in the vertebrate retina. The rods are photoreceptors that contain the visual pigment - rhodopsin and are sensitive to blue-green light with peak sensitivity around 500 nm wavelength. Rods are highly sensitive photoreceptors and are used for vision under dark-dim conditions at night. Cones contain cone opsins as their visual pigments and, depending on the exact structure of the opsin molecule, are maximally sensitive to either long wavelengths of light (red light), or medium wavelengths of light (green light) or short wavelengths of light (blue light). Cones of different wavelength sensitivity and the consequent pathways of connectivity to the brain are, of course, the basis of colour perception in our visual images.