Experiment: 10

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1. Aim/Overview of the practical:

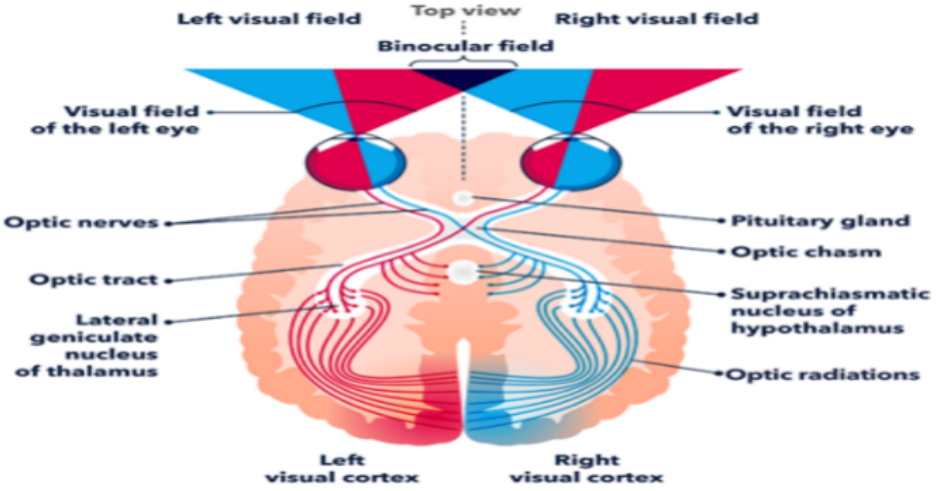
Structure of the human eye; Photoreceptors; Visual pathway; Eye movements

2. Task to be done:

Discuss the visual pathway and eye movements. In Addition, implement as well as write down the steps of working of the visual pathways and eye movements in augmented reality.

3. Theory:

Visual Pathways:
Ideally, the visual pathway is smooth and efficient, with predictable curves and directions leading from the optic nerve to the occipital lobe's primary visual cortex.



Important Parts of the Visual Pathway

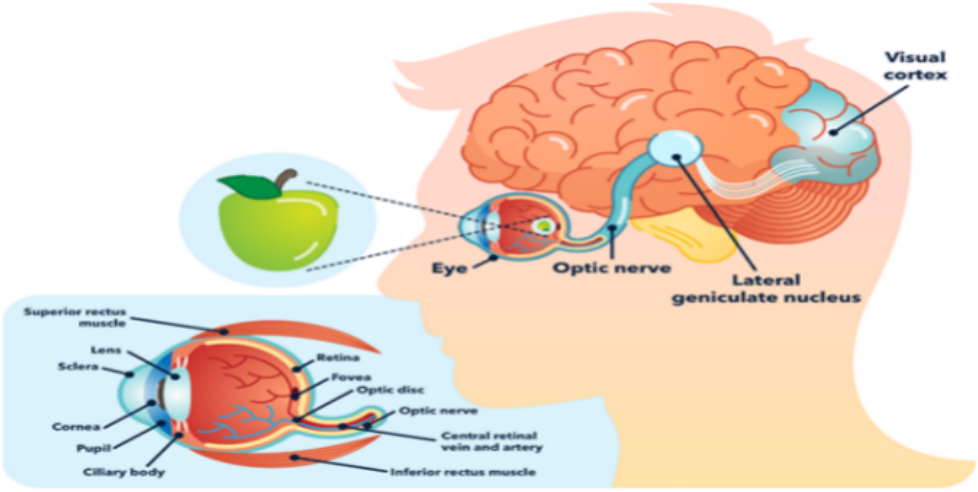
- Retina: This is your eye's on-ramp. It's made up of two types of photoreceptors, rods, and cones, which are neurons that detect light. Rods are on the periphery of your retina. They process low levels of light and motion; cones, mainly in the centre of your retina, distinguish colour and detail.

- Optic nerve: This cranial nerve sends visual information from your retina to your brain. It consists of more than 1 million nerve fibres.

- Optic chiasm: Think of this as an intersection. It's where the nerves cross over, allowing your primary cortex to get information from both eyes. Like a busy intersection, this is where visual information is sorted and broken up into component parts for more processing. The left field of vision is processed by the right side (or cerebral hemisphere), and vice versa, moving along an optic tract toward the thalamus.

- LGN (lateral geniculate nucleus) in the thalamus: Think of this as a central tollbooth where all sensory information stops entering. From here, visual information is organized from the retina and sent off to the primary cortex. Just like a highway, there's one on either side of the thalamus.
- Optic radiations: We're almost at the end of our journey! The optic radiations are axons—or nerve fibres—that convey information to your visual cortex.

- Visual cortex: This is where images received from your retina begin to get processed. The visual cortex has six layers and is the very beginning of your brain's process of interpreting and recognizing what you see. Within these layers, depth perception is processed, and form, colour, and motion are perceived.



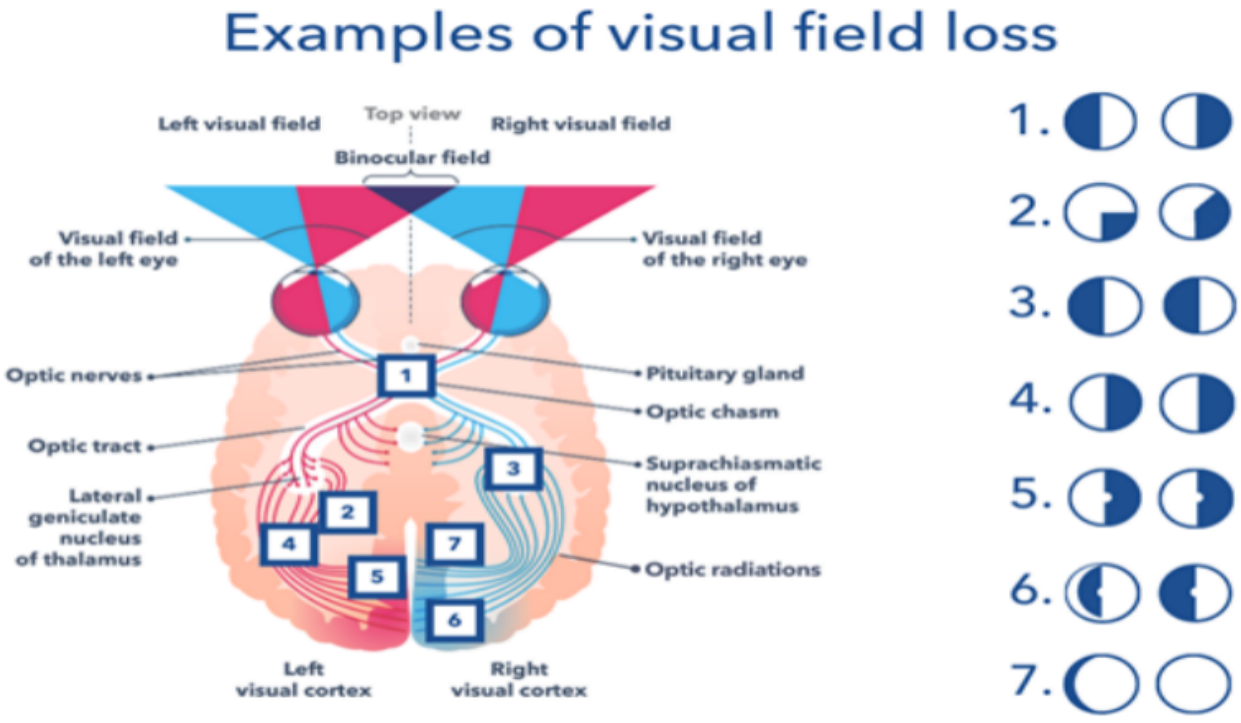
Visual Field:

When our eyes are in a fixed position straight ahead, the area that we see is called a "visual field." This visual field changes with age.

Newborns usually have a visual field of just 30 degrees. But by two months old, it expands up to 90 degrees; by four months, it's 180 degrees.

Visual Field Loss:

It occurs from damage or interruption to the upper part of the occipital lobe. Clinicians and researchers theorize that the upper occipital lobe can be more susceptible to damage; this could be why we see lower visual field loss in children with brain-based visual impairments.



Types of Eye Movements

There are four basic types of eye movements:

- saccades
- smooth pursuit movements
- vergence movements
- vestibulo-ocular movements

Explanations and Functions

1. Saccades are rapid, ballistic movements of the eyes that abruptly change the point of fixation. They range in amplitude from the small movements made while reading, for example, to the much larger movements made while gazing around a room. Saccades can be elicited voluntarily, but occur reflexively whenever the eyes are open, even when fixated on a target. The rapid eye movements that occur during an important phase of sleep are also saccades.

2. Smooth pursuit movements are much slower tracking movements of the eyes designed to keep a moving stimulus on the fovea. Such movements are under voluntary control in the sense that the observer can choose whether or not to track a moving stimulus. (Saccades can also be voluntary, but are also made unconsciously.) Surprisingly, however, only highly trained observers can make a smooth pursuit movement in the absence of a moving target. Most people who try to move their eyes in a smooth fashion without a moving target simply make a saccade.
   The smooth pursuit system can be tested by placing a subject inside a rotating cylinder with vertical stripes.

3. Vergence movements align the fovea of each eye with targets located at different distances from the observer. Unlike other types of eye movements in which the two eyes move in the same direction (conjugate eye movements), vergence movements are deconjugate (or disjunctive); they involve either a convergence or divergence of the lines of sight of each eye to see an object that is nearer or farther away. Convergence is one of the three reflexive visual responses elicited by interest in a near object. The other components of the so-called near reflex triad are the accommodation of the lens, which brings the object into focus, and pupillary constriction, which increases the depth of field and sharpens the image on the retina.

4. Vestibulo-ocular movements stabilize the eyes relative to the external world, thus compensating for head movements. These reflex responses prevent visual images from “slipping” on the surface of the retina as head position varies. The action of vestibulo-ocular movements can be appreciated by fixating an object and moving the head from side to side; the eyes automatically compensate for the head movement by moving the same distance but in the opposite direction, thus keeping the image of the object at more or less the same place on the retina. The vestibular system detects brief, transient changes in head position and produces rapid corrective eye movements.