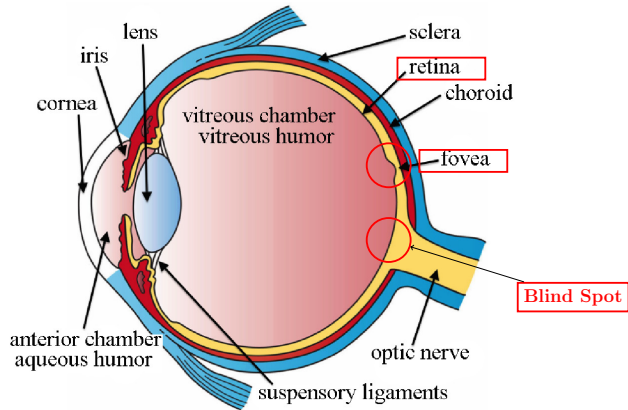


# Biological Vision and Applications

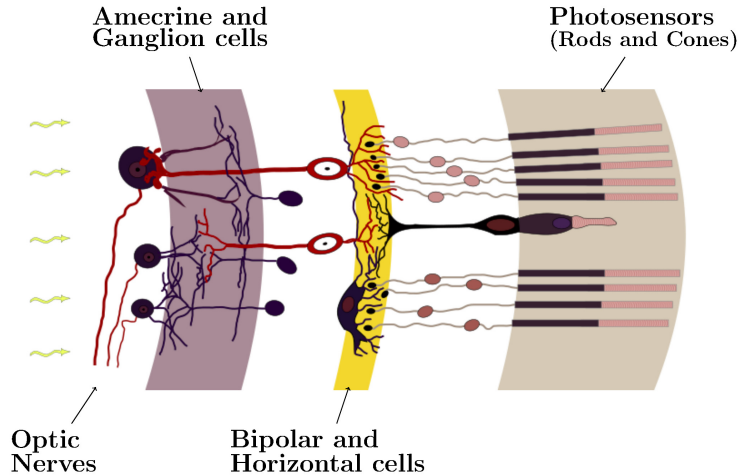
## Module 02-01: Structure of the Eye

Hiranmay Ghosh

# Structure of the eye



# The Retina

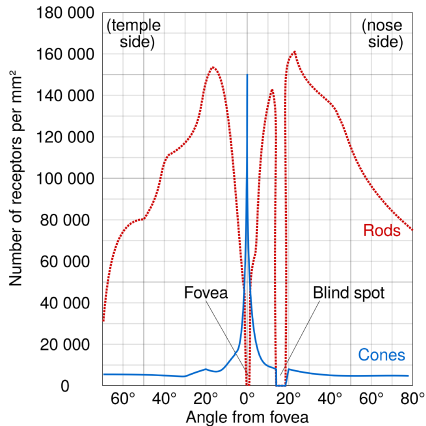


# The Photosensors

## Rods and Cones

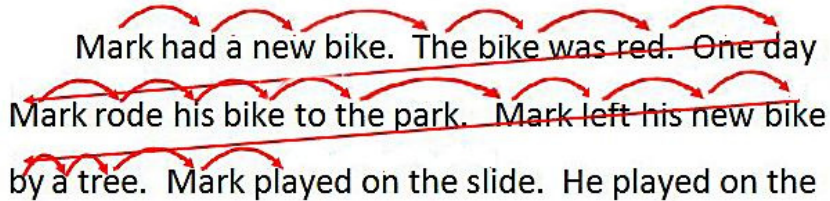
- Rods
  - ▶ More sensitive to light, but insensitive to Color
  - ▶ Responsible for night (low light) vision
  - ▶ About 120 million rods in each eye
- Cones
  - ▶ Enables color vision
  - ▶ Three types of cones with different sensitivity to wavelengths
  - ▶ About 6 million cones in each eye

# The Photosensors are not uniformly distributed over the retina



- Cones cover about 15% of visual field,
  - ▶ This area is called the fovea
  - ▶ Maximum acuity in this area
    - ▶ Best within 1.5 – 2 degrees
- Rods spread over 60 – 80% of visual field
  - ▶ This area is called the peripheral area
  - ▶ Resolution decreases linearly with the distance from the center of the eye

# Attention, Fixation and Saccade



Mark had a new bike. The bike was red. One day  
Mark rode his bike to the park. Mark left his new bike  
by a tree. Mark played on the slide. He played on the

- Attention:
  - ▶ Orient the eye so that the object of interest is seen through the foveal area
- Fixation:
  - ▶ Intermittent stopping of foveal position on a single location when eye acquires information
- Saccade:
  - ▶ Eye movement between two successive fixations

# Experiment

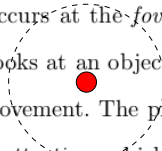
Focus your gaze on the red dot and try to read the text

The uneven distribution of the cones on the retina results in high acuity image to be formed only in the foveal region, which covers about  $1.5 - 2^\circ$  of the visual field. Best acuity occurs at the *fovea centralis* that is about  $\frac{1}{10}$ th of the fovea. When a person looks at an object, it is brought to the center of the visual field with eyeball movement. The process that controls the eyeball movement is known as *visual attention*, which we shall discuss in chapter 5. The image formed in rest of the visual field is with low acuity and contributes to *peripheral vision*.

# Experiment

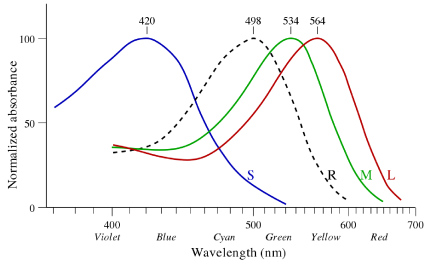
Most of you should be able to read within the dotted circle

The uneven distribution of the cones on the retina results in high acuity image to be formed only in the foveal region, which covers about  $1.5 - 2^\circ$  of the visual field. Best acuity occurs at the *fovea centralis* that is about  $\frac{1}{10}$ th of the fovea. When a person looks at an object, it is brought to the center of the visual field with eyeball movement. The process that controls the eyeball movement is known as *visual attention*, which we shall discuss in chapter 5. The image formed in rest of the visual field is with low acuity and contributes to *peripheral vision*.



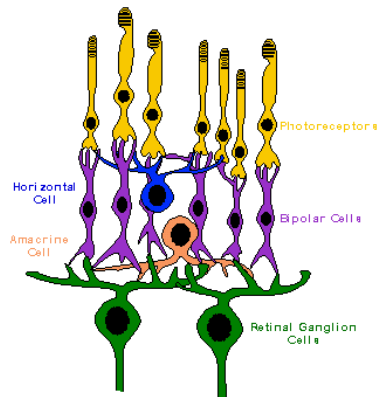


# The cones



- Cone-S, Cone-M, Cone-L:
  - ▶ Maximum response to short, medium and long wavelengths respectively
  - ▶ Response levels of the cones determine color perception
- Rod:
  - ▶ Maximum response at medium wavelength

## Other cells on the retina



- Horizontal Cells
  - ▶ Connects photosensors to neighbors of same kind
- Bipolar Cells
  - ▶ Connects photosensors to ganglions
- Ganglion cells
  - ▶ Connects to brain via optic nerves
- Amacrine cells
  - ▶ Interconnects the ganglions

We shall look at their functions in the following modules

Quiz 02-01

End of Module 02-01