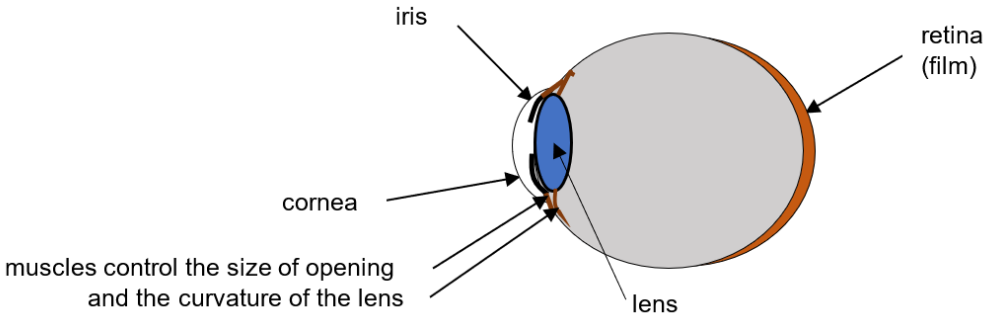
Eyes and Cameras

Over 90 per cent of our brain processing is related to vision. We are constantly aware of the objects around us and the motion of these objects. This awareness is essential to our survival.

How do our eyes capture information? How are they similar to the operation of cameras?

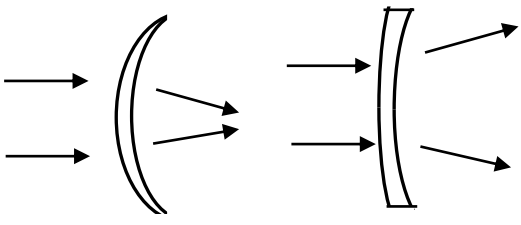


Your eyes have several "automatic" features. First, the eyelid automatically closes when the brain predicts a possible collision with objects. Second, the opening in the eye will be large when the light is low. As the light level increases, the muscles will pull and the opening will get smaller. The black spot in the eye is called the "pupil." This circle appears black because the light entering the eye is absorbed in the retina at the back of the eye.

Try this activity: Sit close to a classmate and look directly into her eyes as she looks into your eyes at a close distance (30 cm.). Have the teacher pull the window blinds and turn off the room lights. After 2 minutes, the teacher should give a loud count-down: 5,4, 3, 2, 1, "now" as she turns on the overhead lights. Notice what happens to the size of your classmate's pupils!

When you gaze at distant objects, the muscles that pull on your lenses will be relaxed. As you concentrate on closer objects, the muscles will automatically pull on the lens in your eye to give it more curvature and bring the objects into focus. Reading for a long period may cause these muscles to become stressed and you may notice tiredness or even a headache. (In a camera system, the lens does NOT change shape, but moves farther from the film (or CCD.)

The adult human eye is about 2.4 cm long and the lens is about the same size as an M&M candy. The length of your eyeball has a lot to do with whether you're nearsighted or farsighted. People who are nearsighted have a longer-than-normal eyeball, while people who are farsighted have a shorter-than-normal eyeball. Just a millimeter change in the length of your eye will change the prescription for that eye. You can wear eyeglasses or contact lenses as shown below to correct these problems.



converging lens diverging lens

- Lenses that are thicker in the middle are converging.
- Lenses that are thinner in the middle are diverging.

Find someone in your class who wears eyeglasses. Try to use the glasses as a magnifying glass. Do they make objects look larger? If so, then the glasses are converging.

Student name: _____ Converging: _____ Diverging: _____

Let's assume that the distance from the cornea to the eye is 2.4 cm. When looking at distant objects the images form at the focal length, so that the "f" for your relaxed eye is also 2.4 cm. Now suppose that you look at a 30 cm tall tulip at a distance of 50 cm from your eye. What happens in your eye? First of all, the muscles pull on your lens to make it more curved which also increases the curvature of the cornea. This causes the focal length to decrease. Now the image will be focused at the retina so the $\mathbf{d_i}$ = 2.4 cm. Use the lens equation to calculate the new focal length:

Now use the pinhole equation to calculate the height of the image on the retina:

Professional photographers use digital cameras to focus the images at the back of the camera. The lenses in the camera are glass so that they cannot change shape. The images are focused by changing the distance between the lens and screen. The focal length of a certain camera is 8.0 cm. The 30 cm tall tulip is 50 cm from the camera lens. Use the lens equation to calculate the value of $\mathbf{d_i}$:

Now use the pinhole equation to calculate the height of the image: