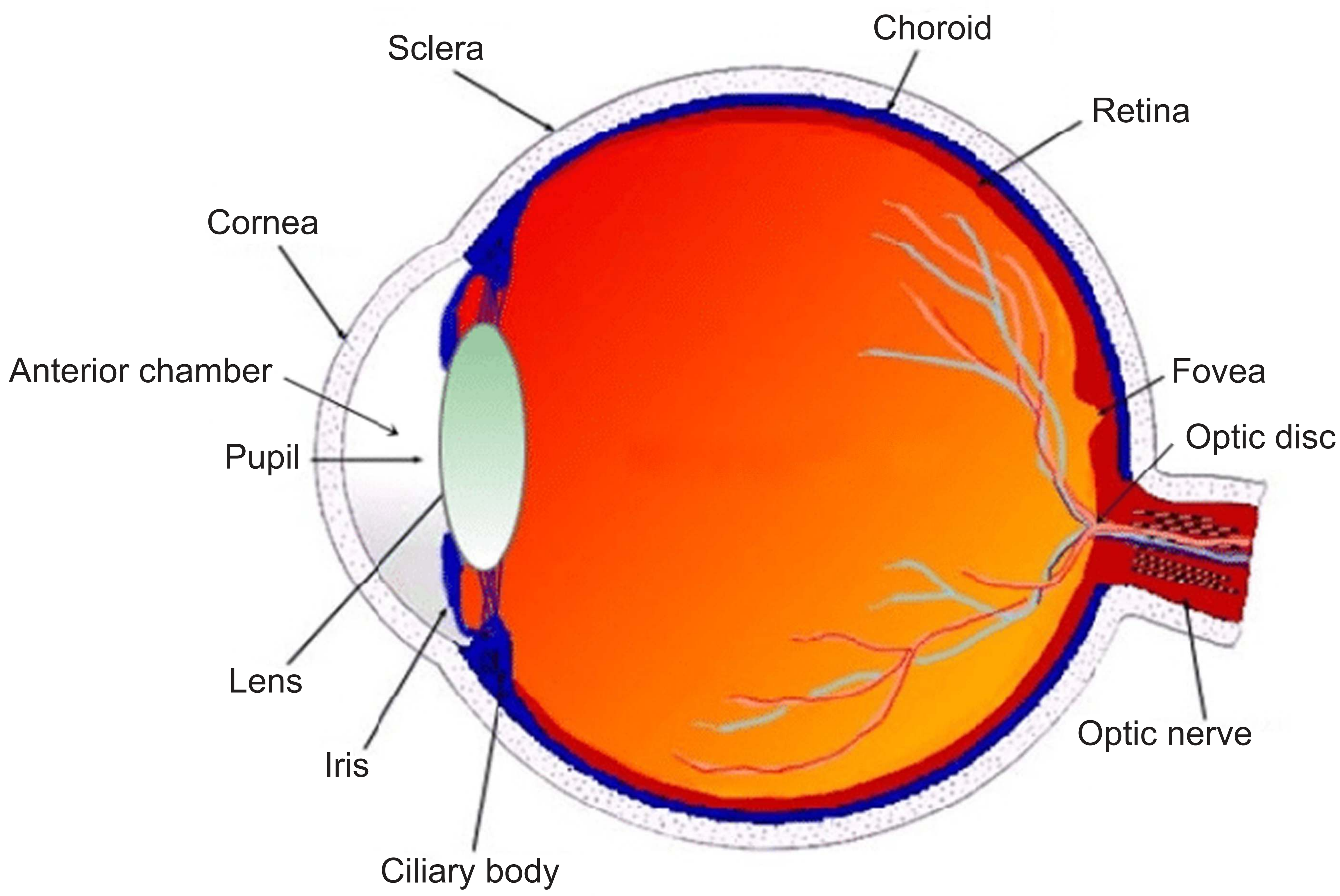
THE EYE

The human eye is the most important and versatile observational aid of all. It has a wide field of vision (120° horizontally, 60° vertically), can centrally observe colours under well-lit conditions (such as daylight), and can peripherally view dimly lit objects in grey scale at night or through binoculars or telescopes. Its magnification is obviously one.



Structure
The key components of the eye are illustrated in the adjacent diagram.

The eye is part of the sensory nervous system. As such, the eye does not see, the ear does not hear and the fingers do not feel. These organs, together with the nose and tongue, are simply sensors that pass information to the brain for interpretation.

Light Perception
The retina contains two types of light detection sensors:

- By far the largest number of cells are *Rod Cells*, which are extremely sensitive and can be triggered by a single photon. They are therefore the sole source of low-light vision. They outnumber cone cells by 20:1 and are concentrated away from the central optical axis.
- The three types of *Cone Cells* respond best to red, green and blue wave lengths and therefore enable colour vision. They are concentrated on the optical axis and therefore give accurate spatial resolution but they require more photons than rod cells to trigger visual perception. This explains why colours cannot be distinguished in low light.

The retina as a whole is most sensitive to green light because the sunlight in which *Homo sapiens* evolved has its peak spectral intensity at the green wave lengths.

Dynamic Range
The eye focuses incoming light through the fixed refractive surface of the cornea and through the variable lens which adjusts the focal length for the object-to-eye distance to project a focussed image onto the retina.

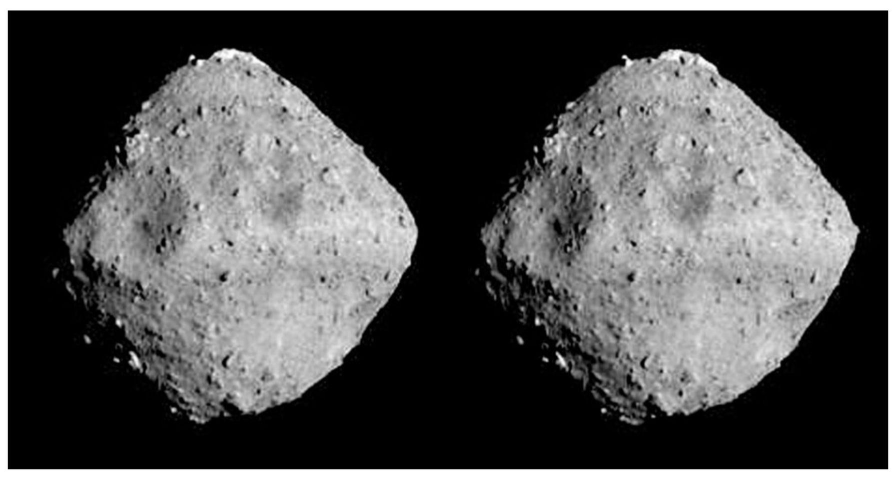
The retina has a static contrast ratio of around 100:1, or about 6.5 f-stops in camera terms. Whenever the eye moves to follow a target, it re-adjusts its exposure by adjusting the iris, which adjusts the size of the pupil (aperture).

The dynamic range of the eye does NOT include the Sun. Permanent eye damage may result from direct observation of the Sun (or lightning).

Dark Adaptation
Initial dark adaptation takes place in about four seconds of uninterrupted darkness. Full dark adaptation through adjustments in the retinal rod photoreceptors is 80% complete in 30 minutes. Any interruption by light exposure requires the dark adaptation process to start over again.

Binocular Vision
Binocular vision through our eyes is enabled by two different perspectives being sent to the brain from eyes laterally separated by the inter-pupillary distance. This enables depth perception as well as the ability to estimate distance.

Stereoscopic Vision
Astrophysicist and lead guitarist of the rock band, 'Queen', Dr Brian May, created this stereoscopic image, a composite based on two exposures taken 13 minutes apart, of Asteroid 162173 *Ryugu*, which is 280 million km from the Earth.



Face the image squarely and try to focus through the gap between the photographs to a point behind them. With a little practice you should be able to combine them into a third image, with one in the middle, which will be stereoscopic! This exercise will not damage your eyes. If you do not succeed, as many people won't, don't worry about it!

Fixational Eye Movements
The eyes drift around even when looking intently at a single spot to ensure that individual photosensitive cells are continually stimulated to different degrees. Without a continuously changing input, these cells would otherwise stop generating output.

Averted Vision
Astronomers use averted vision to observe a dim object or to see more detail of any object. This is done by not looking directly at the target object but rather slightly away from it. This projects the image to the outer areas of the retina where the more sensitive rod cells are concentrated and enhances the image.

Blind Spot
Each eye has a tiny blind spot about the size of a pinhead where there are no photo-receptor cells to detect light in the location where the optic nerve and blood vessels pass through the retina. This is only the case in vertebrate eyes (such as those of humans) in which the nerves are routed *in front of* the retina. In invertebrate eyes (such as those of the octopus), the nerve fibres are routed *behind* the retina and do not create a blind spot.