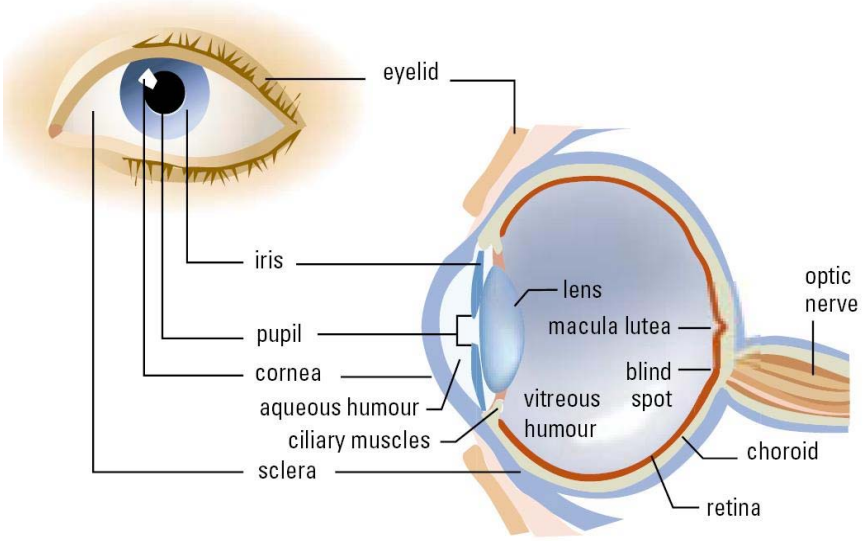
THE HUMAN EYE

We've looked at lenses, but now lets look at our eyes and the lenses/mechanics involved in human sight.

The eye is just a device for capturing light and sending it to the brain to be interpreted.



Light enters through the **cornea** (protective/transparent part of the eyeball or sclera) and passes through the **pupil**.
Light can pass through the cornea even though it is made of living cells, it is completely clear. The cornea is made up of strong tissue that is strong enough to protect your eye, but is still sensitive to touch, the cornea can heal itself. The light rays arriving at the eye are refracted by the cornea.

After passing the cornea, the light rays reach the **pupil**.
(FYI: 'pupil' is derived from the Latin word 'pupa', meaning little doll, indicating the tiny reflections of people visible in pupils.)

The pupil is the dark circle that you can see when you look at someone's eye. The pupil is created by a circular band of muscle called the **iris**.
(The doughnut-shaped ring is called the iris diaphragm, or simply, the iris.)

(FYI: the word 'iris' is derived from the Greek word for rainbow, the iris in the eye determines the colour of an individual's eye.)

The size of the pupil is controlled by the iris, and hence the iris controls the amount of light that enters the eye. In dim light the iris opens up and the pupil dilates and so it lets in more light, however in bright light, the iris closes and the pupil contracts, i.e. it becomes smaller, thus less light enters.

Light entering the cornea and passing through the iris is then focused by the **convex lens** of the eye, to form an image on a thin, curved layer of light sensitive cells st the back of the eye, that can act as a projection screen, called the **retina**.

The convex lens of the eye is flexible, it is able to adjust its focal length because it is attached to the ring-shaped **ciliary muscles** surrounding it. The lens is thinner at the middle when the ciliary muscles are relaxed and thicker when they are contracted.

The process of changing the shape of the lens, (due to the pressure of the ciliary muscles), to make it possible to see nearby and faraway objects clearly is called **accommodation**.

The shape of the eye is maintained by the pressure of colourless, transparent fluids in the eye.
The eye is filled with a watery substance between the pupil and cornea, and a jelly like substance inside (aqueous humour and vitreous humour).

In order for you to see, light rays must be absorbed by **photoreceptors**, which are cells in the retina that are sensitive to light.
The retina has 2 basic cell types:
1. **Rod cells** (majority at 120 million) which are low light sensors but are black and white, and
2. **Cone cells** (7 million) which are able to detect colour.

There are red, green and blue cone cells, each detects "its" colour by means of pigment that absorbs the light (breaks up and then later recombines) and emits electrical energy to the **optic nerve** to the brain.

The image on the retina is inverted and reversed, but the brain straightens this out and you 'see' the image right way up.
The **macula** is a very sensitive part of the retina that is responsible for detail imaging (looking straight ahead).

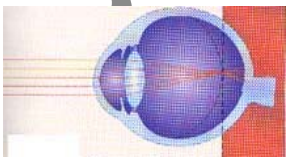
The one point that cannot detect light is our **blind spot** where the optical nerve attaches to the retina**.** The optic nerve connects the eye to the brain. Your brain 'fills in' the blind spot with whatever colours are nearby in what you are looking at.

Defects in Vision and Their Correction

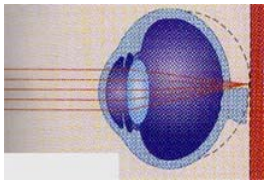
In order to see, we must have an image reduced in size, focused on the retina, curved to match the retina's surface. When all three conditions are not met we have a vision problem.

Vision Problems and Treatment

Term (medical)	Layman's Term	Problem	Correction
Myopia	Nearsighted	Image in front of retina, or lens-retina distance too great	Divergent lenses (slightly)
Hyperopia	Farsighted	Image behind retina, or lens retina distance too small	Convergent lenses (slightly)
Presbyopia	Farsighted / Loss in Accommodation	Loss of elasticity in lenses	Convergent lenses, bifocals
Astigmatism		Non perfect spherical lenses or cornea (different focal planes)	Lenses with different radii
Glaucoma		Damage to optic nerve often from intraocular pressure	
Cataracts		Opaque/cloudy area on lens	Removal of lens



Myopia



Hyperopia

Assignment

1. What is the function of the cornea?

(The cornea protects the eye and refracts light into the eye.)

2. What structures control the amount of light that enters the eye?

(The eyelids can block out sudden bright light, the iris controls the size of the pupil and is responsible for the mount of light entering the eye.)

3. What is the function of the retina?

(The retina is the screen where a real image is projected, and it has cells that can detect light and signal the brain)

4. What does the optic nerve connect? (The optic nerve connects the photoreceptors to the brain.)

5. Where is the blind spot located?

(The blind spot is the place on the retina where the optic nerve leaves the eye.)

6. Compare the pupil to the doughnut hole. In this analogy, what structure in the eye represents the doughnut ? (The doughnut represents the iris.)

7. In the human eye, the _____ performs the same function as the digital sensor in a camera. (Retina)

8. Presbyopia is a condition that results in _____. (far- sightedness)

9. In the eye of a person with hyperopia, light from some objects is focused_____ of the retina. (Behind)

10. _____ is the process of changing the focal length of the lens in the eye. (Accommodation)

11. In the eye of a person with myopia, light from some objects is focused _____ the retina. (In front of)

12. What is accommodation? (A)

a. the process of changing the focal length of the lens in the eye

b. the loss of elasticity in the lens of the eye that results in presbyopia

c. the process of changing the size of the iris to allow more or less light into the eye.

d. none of the above

13. Which of the following is an age-related condition? (C)

a. hyperopia b. myopia c. presbyopia d. geriopia

14. You are looking closely at a leaf. How is the shape of your eye changing ? (B)

a. The lens is getting thinner. b. The lens is getting thicker.

c. The lens is moving closer to the retina. d. The lens is moving farther from the retina.

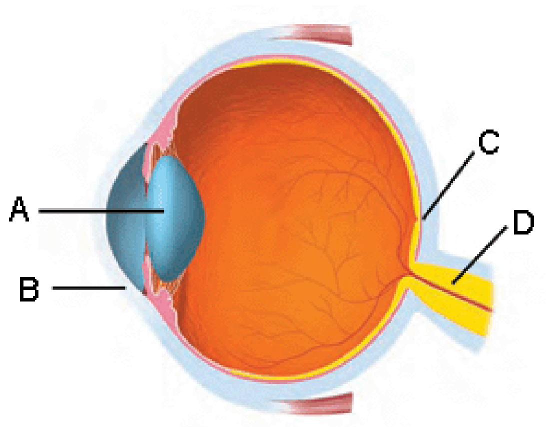
15. What is far-sightedness and what type of lens should a person who is far-sighted use ?

(In far-sightedness, the eye focusses the image of a close object behind the retina, and a converging, i.e. a convex lens should be used.)

16. What is near-sightedness and what type of lens should a person who is near-sighted use ?

(In near-sightedness, the eye focusses the image of a far object in front of the retina, and a diverging, i.e. a concave lens should be used.))

17. Match each feature with its function.



a. image forms here
b. carries image to brain
c. focuses light
d. most refraction occurs here

[a. position C on the diagram b. position D on the diagram]
[c. position A on the diagram d. position B on the diagram]

18. What are the similarities and differences between hyperopia and presbyopia?

Both are far-sightedness—the person can see distant objects well but not close-up objects. The cause of hyperopia is a misshapen lens that focuses *behind* the retina. A person with presbyopia has a very similar problem but it is due to lack of elasticity rather than a misshapen lens. Due primarily to aging, a presbyopic person just cannot switch back and forth between far-vision and near-vision. The lens is in a sense "permanently stuck" in far vision mode

19. What happens during accommodation, and what does it accomplish?

Muscles around the eye's lens change the shape of the lens. This changes the focal length of the lens, allowing the eye to focus on both near and distant objects.

20. What are the similarities and differences between a film camera and the human eye?

Both have parts that open and close to control the amount of light that enters. On the camera, it is the diaphragm; in the eye, it is the pupil. Both have parts that focus the light rays that enter. On the camera, it is the lens; in the eye, it is the cornea and the lens. Both form a smaller, inverted, real image on a back surface. On the camera, the image forms on the film; in the eye, the image forms on the retina. The eye has an optic nerve to carry signals from the retina to the brain, but the camera has no analogous part. Also, the eye is living tissue while the camera is a manufactured machine.