SENSE ORGANS

VISION

EYE

- The eye allows us to see and interpret the shapes, colors and dimensions of objects in the world by processing the light they reflect or emit
- The eye is able to see in bright or dim light, but it cannot see objects when light is absent

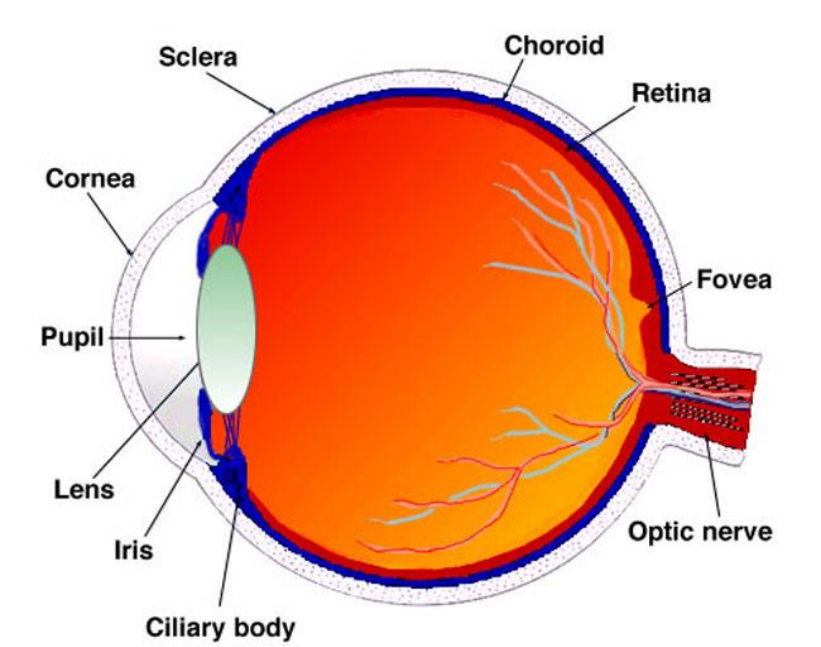


Fig. 6. Vertical sagittal section of the adult human eye.

EYE STRUCTURE AND FUNCTIONS

The eyeball has three coats:

1. Outer coat – **SCLERA** – preserves shape of eyeball and protects delicate inner layers.

2. Middle coat – **CHOROID**. Contains rich blood supply and melanin. Circular opening at front – **PUPIL**. Coloured muscular ring – **IRIS** – surrounds pupil, and controls size of pupil:depth of focus; amount of light entering eye. CILIARY BODY produces aqueous humour. **CILIARY MUSCLE** – circular – has sphincter – like action. **SUSPENSORY LIGAMENT** – relaxes to allow curvature of lens to alter for accommodation. **CRYSTALLINE LENS** – brings light rays to focus on light-sensitive retina.

3. Inner coat– the **RETINA**. Lines back of eye. Contains receptors for vision – highly specialized to respond to stimulation by light. Convert light energy into nerve impulses. **OPTIC NERVE** conveys these impulses to **VISUAL CENTERS** In **OCCIPITAL** (posterior) part of **BRAIN**.

MUSCLES OF EYE

The **eyeballs** are moved by **small muscles** which link the **sclerotic coat** to the **bony socket.**

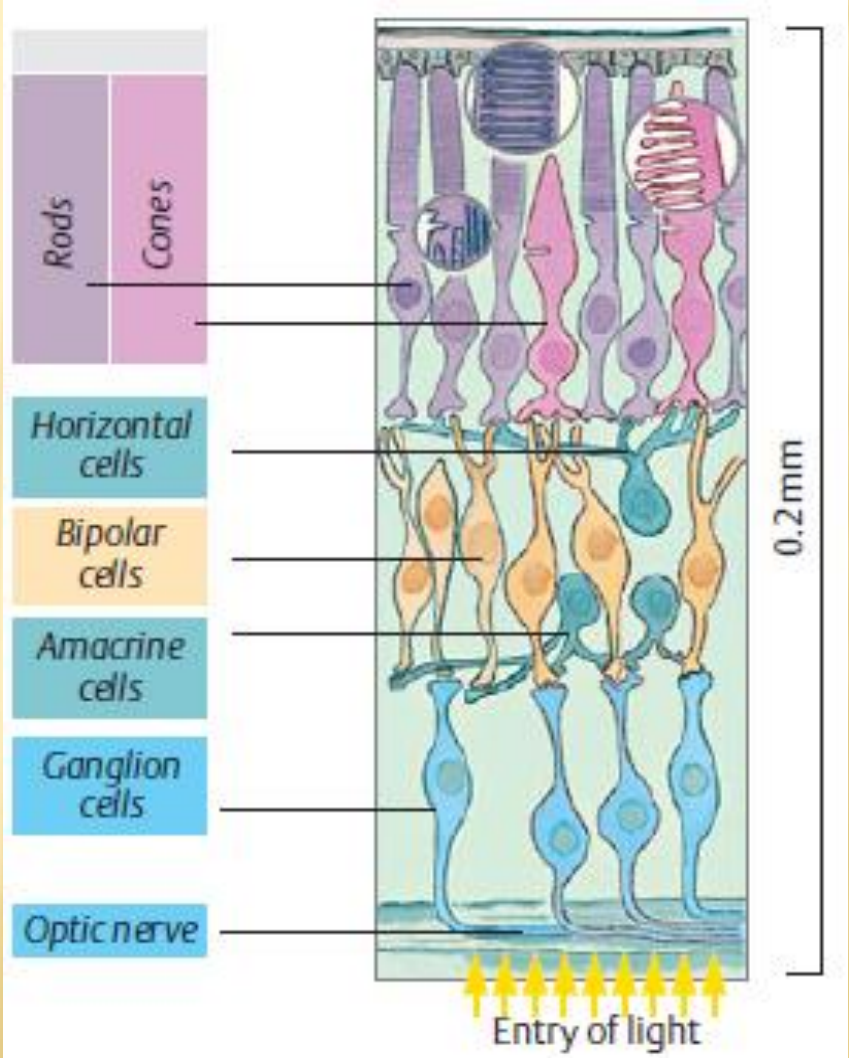
Acting together, the extrinsic muscles of the eyeballs can bring about rotator movements of the eyes.

The extrinsic muscles are supplied by motor fibers from cranial nerves III, IV and VI. Because these muscles have to perform very fine and precise movements, the size of their **motor units** is small.

RETINA

- Optic cup differentiate as two layers
  - Outer layer – RPE
  - Inner layer – Sensory Retina
- Retinal Layers

1. Retinal Pigment Epithelium
2. Rods and Cones
3. External limiting membrane
4. Outer nuclear layer
5. Outer plexiform layer
6. Inner nuclear layer
7. Inner plexiform layer
8. Ganglion cell layer
9. Nerve fibre layer
10. Internal limiting membrane



RETINA

RODS AND CONES

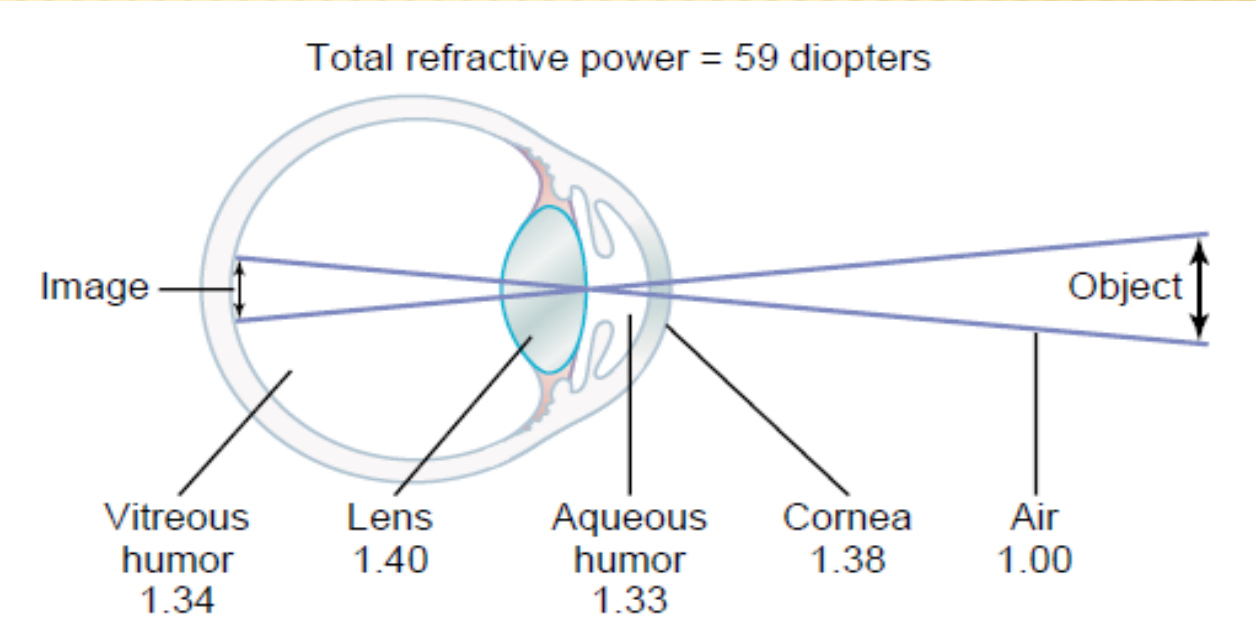
(PHOTORECEPTORS)

- Are light sensitive element of retina
- Rods function at low level of illumination (Scotopic vision)
- Cones function at medium and high level of illumination (Photopic vision)
- Cones are mainly found in fovea
- Rods are mainly found in peripheral retina
- Outer segment of photoreceptors are removed diurnally and regenerated by inner segment

RODS AND CONES (PHOTORECEPTORS)

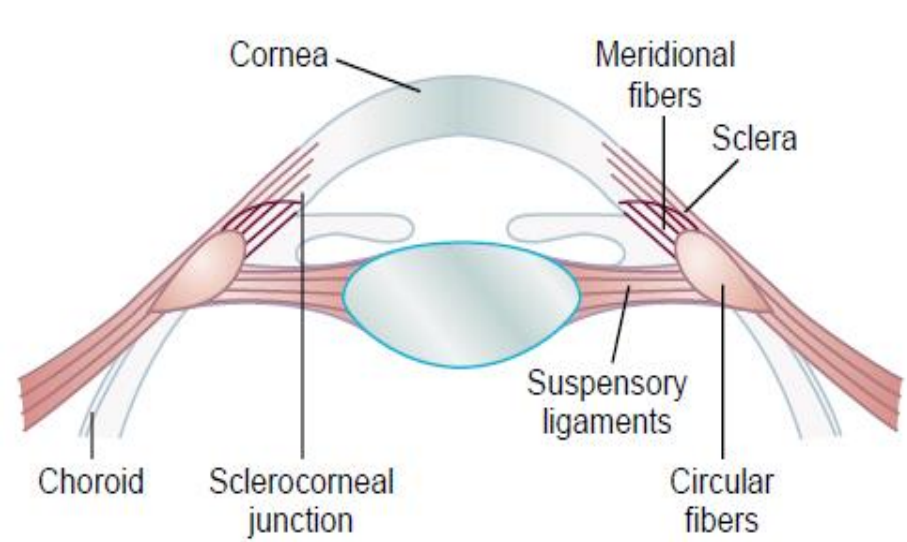
- Outer segment contain light sensitive pigment i.e. Rhodopsin in rods and three photopigments in cones
- Axons of Rods and Cones synapse with bipolar cells and amacrine cells which in turn synapse with ganglion cells
- Axons of ganglion cells form optic nerve which extend to brain
- Sensory retina contain 100 million rods and 6 million cones
- Optic disc has no photoreceptors and is a blind spot in the visual field

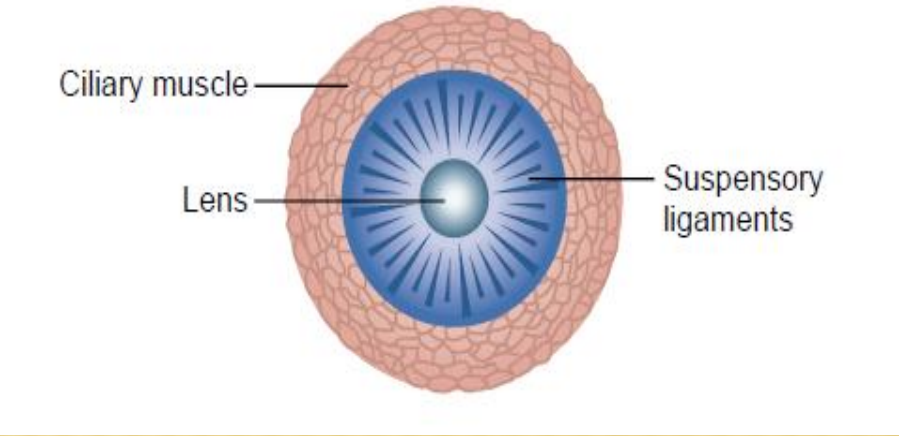
- All the refractive surfaces of eye are algebraically added & considered as a single lens
- It has a central point 17mm in front of retina
- Refractive power of +59D- 2/3rd is provided by cornea & 1/3rd by lens



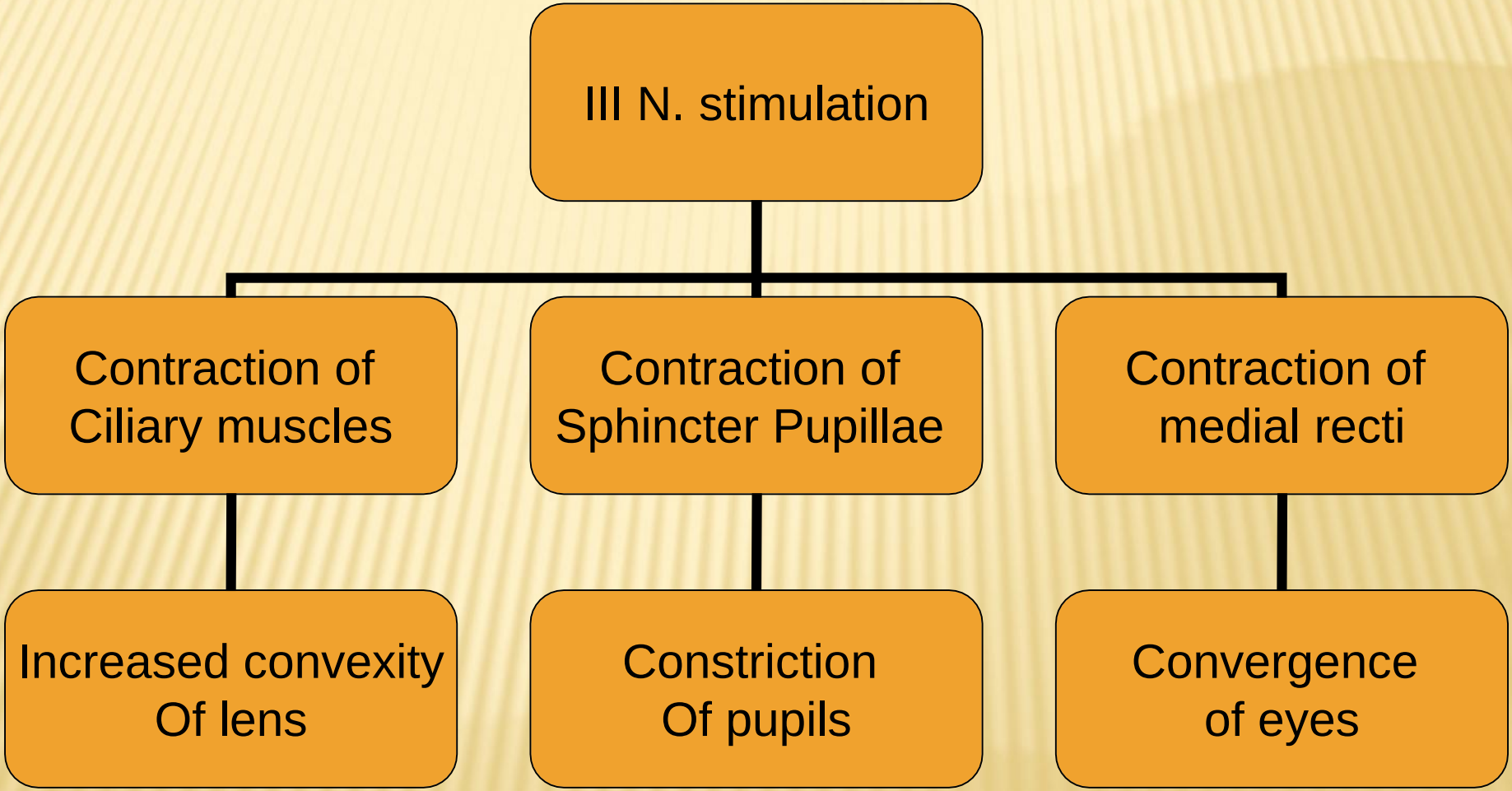
Accommodation

- Lens power +20D
- It can be increased to +34D
- Lens ligaments are constantly under stretch
- Ciliary bodies contract & pull suspensor ligaments towards corneo-scleral junction
- Tension is released & lens assumes more spherical shape
- Controlled by parasympathetic nerves





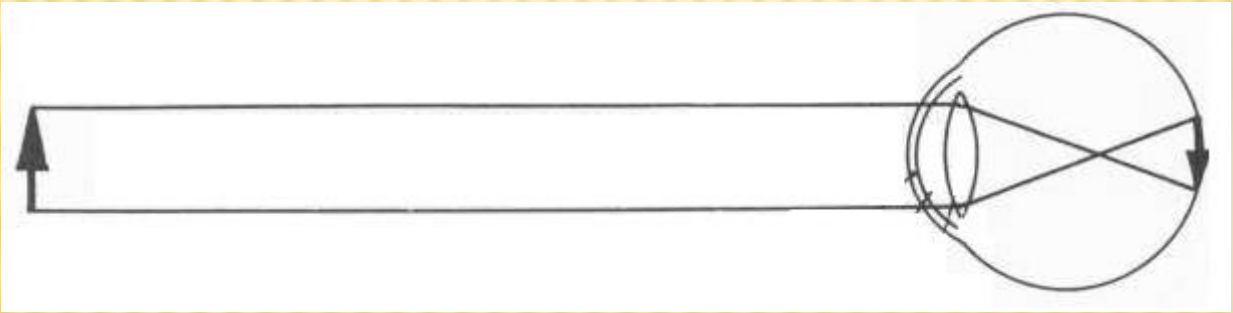
Mechanism of accommodation



ACTION OF LENS

The normal lens brings light rays to a sharp focus upside down on the retina. It can do this whether we are looking at an object far away or one close at hand. The curvature increases reflex to accommodate for near vision. The conscious mind learns to interpret the image and project it to its true position in space.

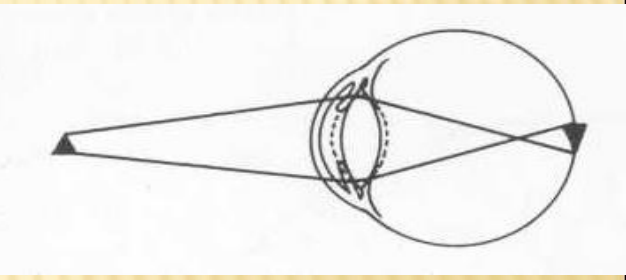
Rays of light coming from every point of a DISTANT OBJECT (over 20 feet away) are parallel.



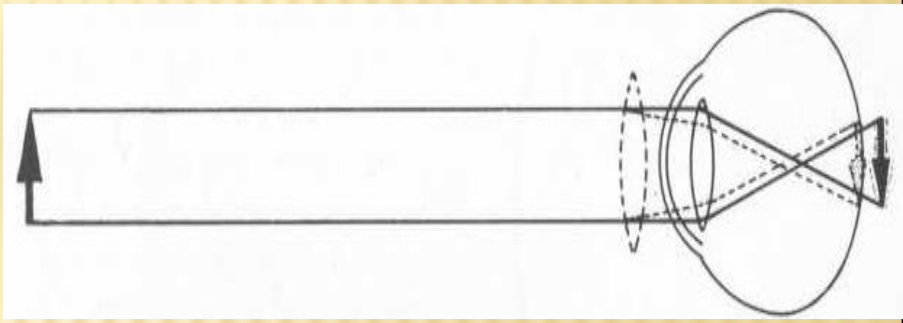
The LENS refracts them to a sharp focus – upside down and reversed from side to side – on the retina.

ACTION OF LENS

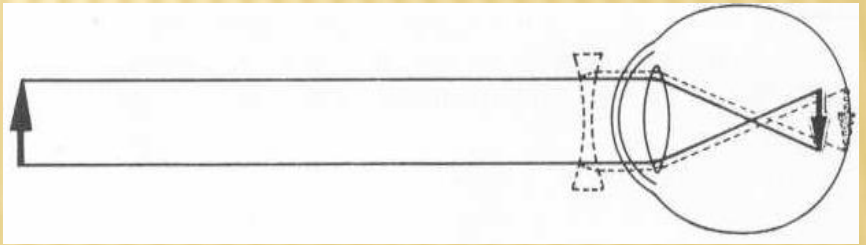
Rays of light coming from a NEAR object (less than 20 feet away) DIVERGE as they pass to the eye.
A more convex lens is required to bring these rays to a sharp focus on the retina.



If the EYEBALL is too short, rays from a distant object are brought into focus BEHIND the retina when the ciliary muscle is relaxed. This is **longsightedness or hypermetropia.**



If the EYEBALL is too long, rays from a distant object are brought into focus IN FRONT of the retina. This is **shortsightedness or myopia** – only object near the eye can be seen clearly.

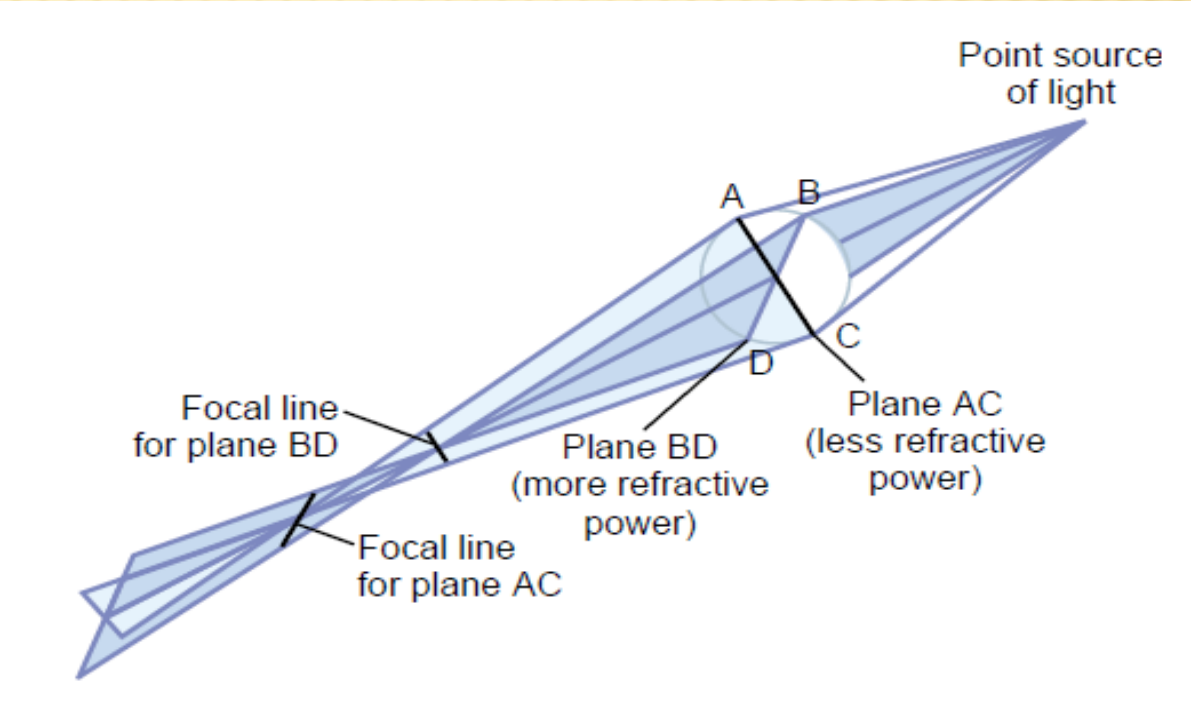


Total refraction of the optical system = 60 dioptres. The lens contributes 9-10 dioptries – the cornea most of the remainder.

Astigmatism:

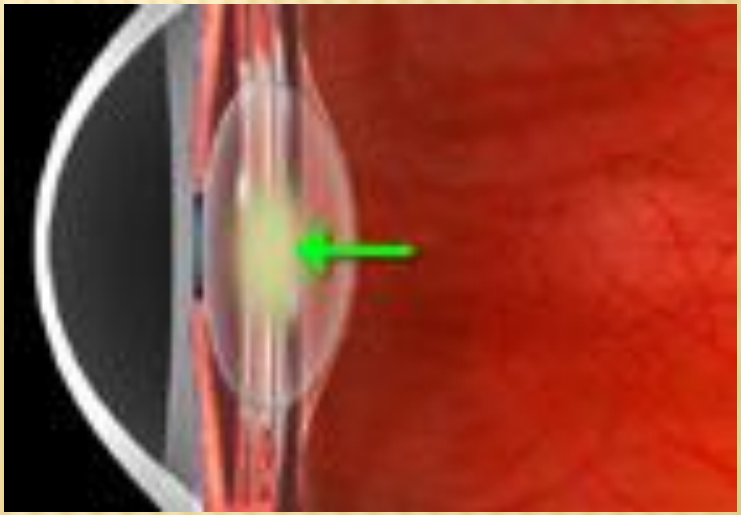
Stigma=point

Different curvatures in different planes of cornea or lens



Diseases of the Eye

- A cataract is a clouding of the eye's natural lens, which lies behind the iris and the pupil
- The lens is mostly made of water and protein. The protein is arranged in a precise way that keeps the lens clear and lets light pass through it. But as we age, some of the protein may clump together and start to cloud a small area of the lens. This is a cataract, and over time, it may grow larger and cloud more of the lens, making it harder to see



Diseases of the Eye

- Researchers are identifying factors that may cause cataracts such as:
  - People with diabetes
  - Users of steroids, diuretics, and major tranquilizers
  - Users of a lot of salt
  - Cigarette smoke
  - Air pollution
  - Heavy alcohol consumption

Diseases of the Eye

Glaucoma

- Glaucoma represents injury to the optic nerve secondary to elevated pressure inside the eye. However, there are exceptions to this definition
- Some patients with sustained high intra-ocular pressure never develop any of the signs of optic nerve damage and therefore, do not truly have glaucoma. These patients are said to have ocular hypertension
- Other patients may progressively lose vision and become blind, even though they never exhibit "high" eye pressures. These patients have low tension glaucoma (also called normal tension glaucoma)

CONTROL OF EYE MOVEMENT

Both eyes must move in a synchronized fashion in order that visual images fall at all times on exactly corresponding points of both retinas.

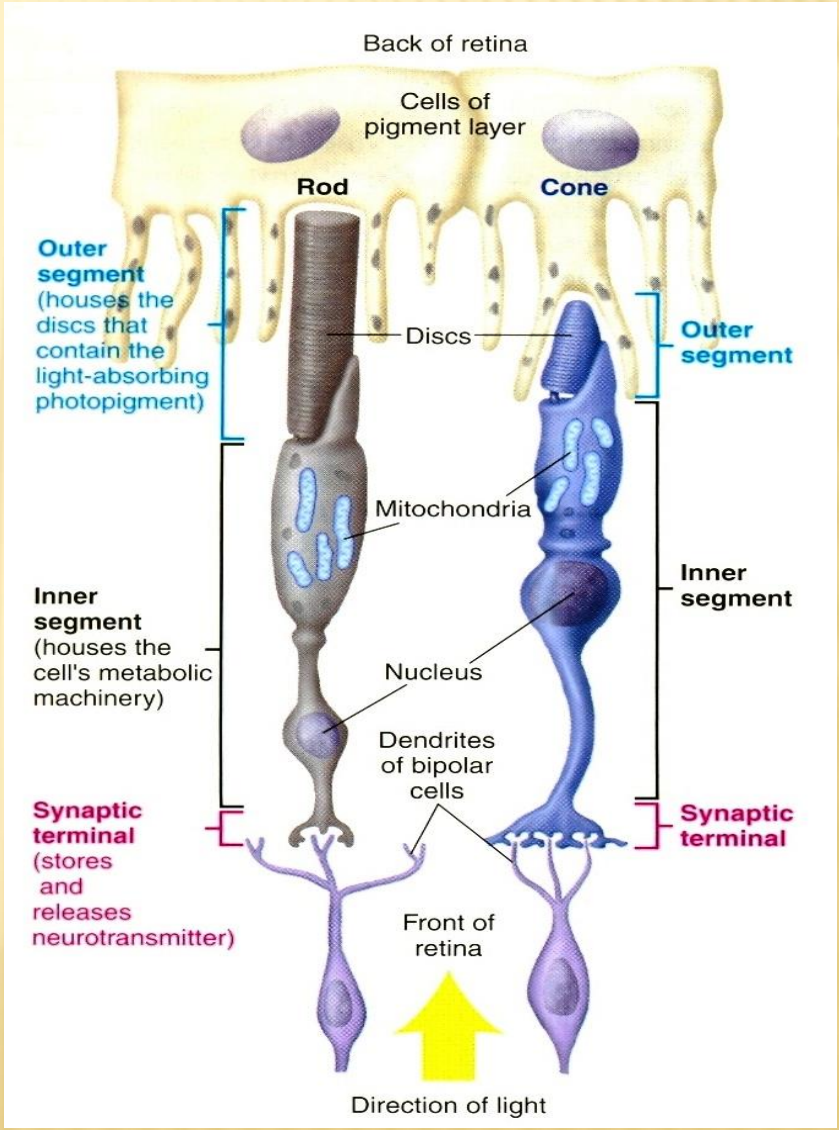
From the right side of the midbrain and pons impulses pass to the prime movers – right ext. rectus & left int. rectus – which contract (+). The antagonists – left ext. rectus & right int. rectus – relax (-) to permit the movement. Both eyes turn to the right. This is **conjugate movement.**

VOLUNTARY EYE MOVEMENTS. To look at an object, movements are initiated in motor centers in the *FRONTAL LOBES*. Impulses from one side of the *cerebral cortex* turn both eyes to the other side of the field of vision.

REFLEX EYE MOVEMENTS. *SACCADES* – rapid jerky movements from one fixation point to another – allow sweeping search of visual field and move visual images over receptors, preventing adaptation. Also occur during sleep. Control is from frontal eye fields exerted through the *superior colliculus*.

Color vision

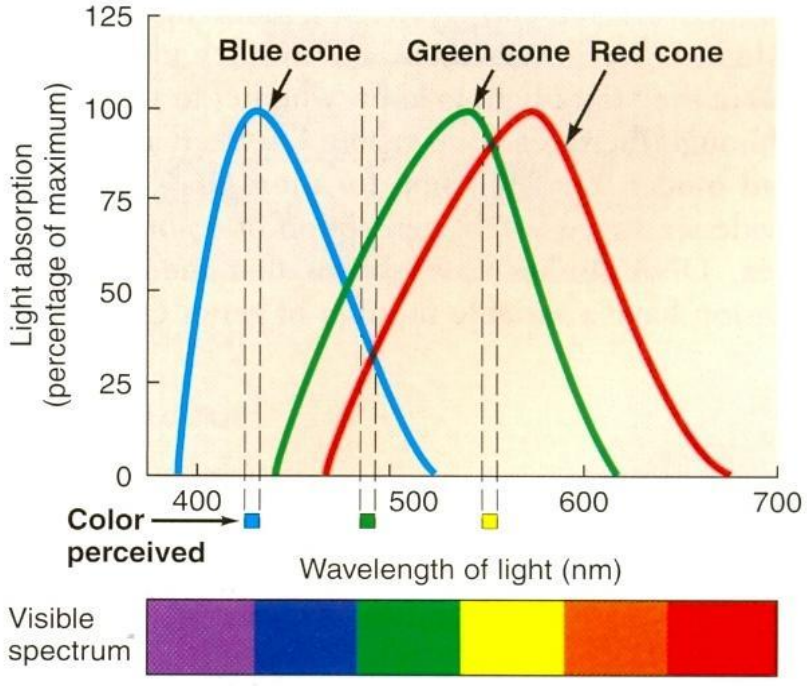
- The **rod cells** contain rhodopsin, a protein partially derived from vitamin A.
- Rods are sensitive to light and enable us to see in dim light.
- The **cone cells**, contain iodopsin, are used for fine details and bright, color vision.



Color vision

- Humans have three types of cones, each sensitive to a different color of light: red, blue and green
- Center of the macula : **fovea** contains maximum no of cones

Visible light: 400-750 nm



Color perceived	Percent of maximum stimulation		
	Red cones	Green cones	Blue cones
	0	0	100
	31	67	36
	83	83	0

Sensitivity of the three types of cones to different wavelengths
The ratios of stimulation of the three cone types are shown for three sample colors.

MECHANISM OF VISION

In the DARK

Activation of a G protein
↓
Activates guanylate cyclase
↓
Increases synthesis of cyclic guanosine monophosphate (cGMP)
↓
Holds Na^+ channels open
↓
Inflow of Na^+ (and Ca^{++}) (called the dark current)
↓
Depolarizes rod membrane
↓
Increases glutamate release at synaptic terminals
↓
Hyperpolarizes bipolar cell by opening Cl^- channels
↓
Inhibits ganglion cells of optic nerve fibres

In the LIGHT

Isomerization activates G protein **transducin**
↓
Activation of enzyme phosphodiesterase
↓
Breakdown of cGMP
↓
Closure of Na^+ channels (Ca^{++} influx also decreased)
↓
Hyperpolarizes rod membrane
↓
Decreased release of glutamate
↓
Depolarization of bipolar cell
↓
Increases release of glutamate from bipolar cell
↓
Produces action potentials in ganglion cells of optic nerve fibres

Photopic vision is vision in bright light. It depends on the **cones**.

Cones are of 3 types ——— and give **TRICHROMATIC VISION**.

Each type with a different photosensitive **VISUAL PIGMENT**— which absorbs light most effectively at a different part of the visible spectrum thus changing its structure.

Each contains RETINAL, the aldehyde of vitamin A, plus one of 3 opsins which filter the light before it reaches the retinal.

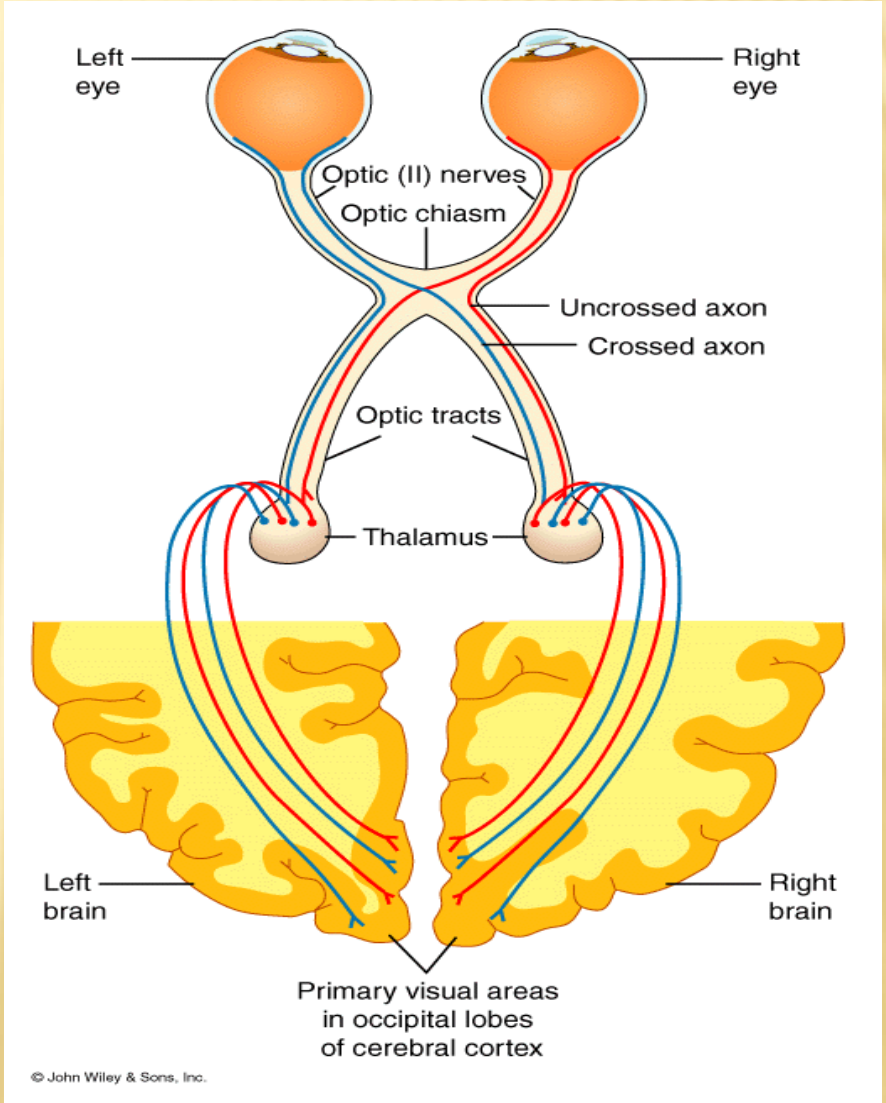
'*RED*' responds maximally to *YELLOW-ORANGE* light (558 nm)

'*GREEN*' responds maximally to *GREEN* light (531nm)

'*BLUE*' responds maximally to *BLUE* light (420nm)

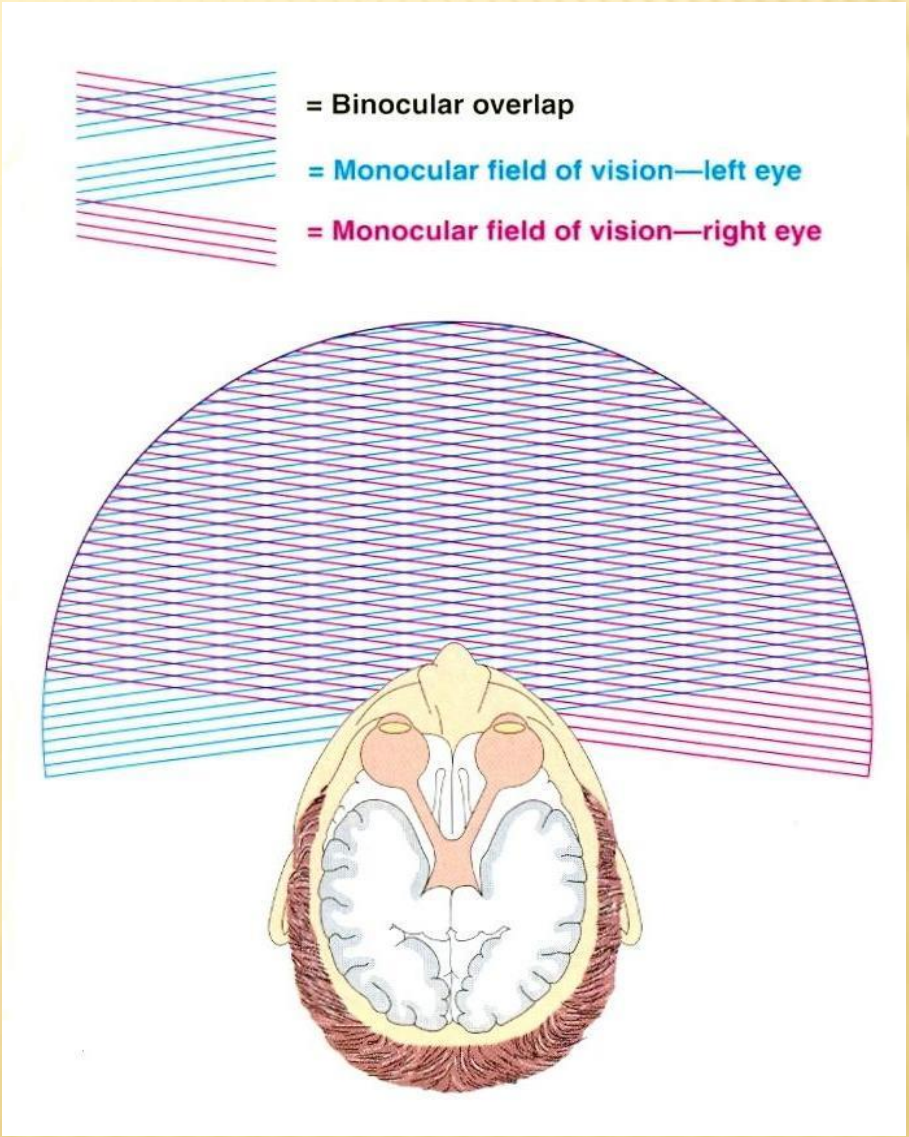
- Information is passed to the **ganglion cells** which send their **axons** to form **optic nerves**
- **Optic Chiasma** is the portion where optic fibers from the **nasa**l portion of each retina cross.
- **Optic Tracts.** fibers from chiasma join the fibers from the temporal portion of the retina on the opposite side.

- Left optic tract = impulses from Right visual field,
- Right optic tract = impulses from Left visual field.



BINARY VISION

- When both eyes are looking at an object, image is formed on retina.
- Left half of visual field falls on the right side of each retina and vice versa.
- Upper and lower fields fall on opposite halves of retina

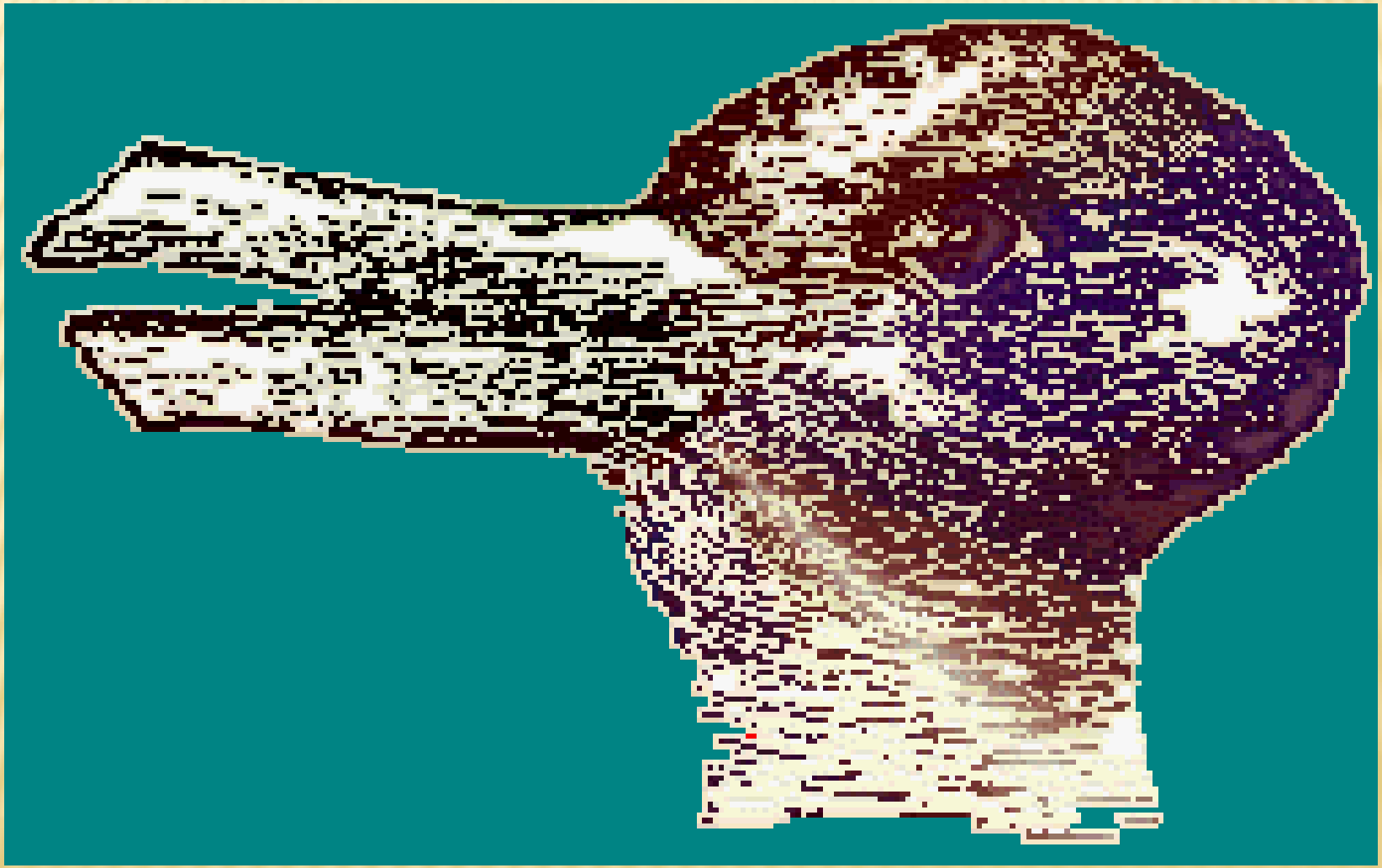


- The brain takes the picture seen by each eye and combines them to make one picture.

Sometimes our brain is tricked into seeing things that aren't real. These are called optical illusions.

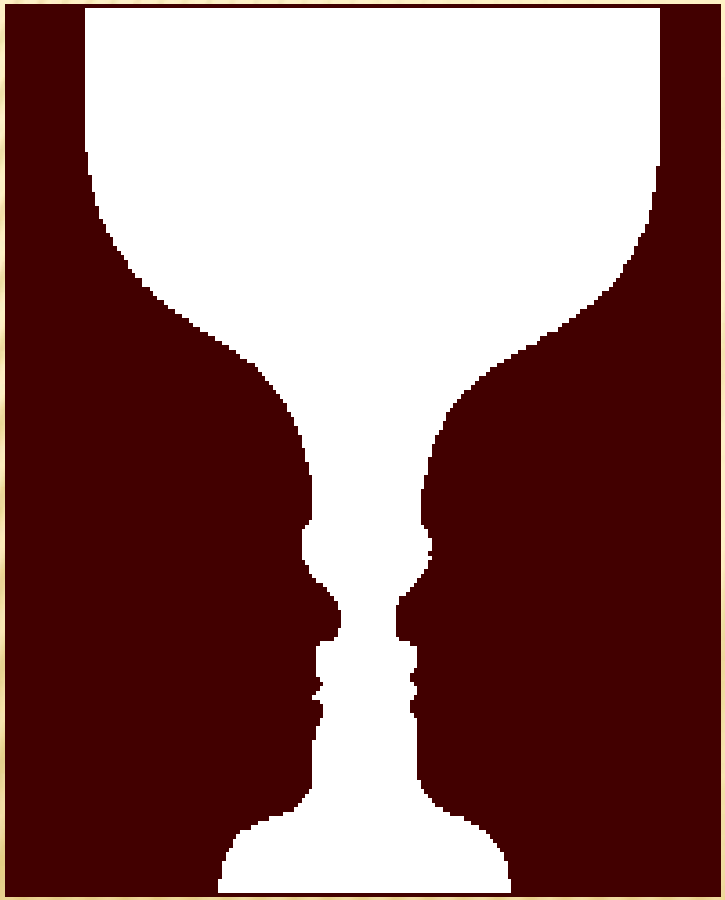
Let's try some!

This Is a Bunny/duck Illusion. Do You See the Bunny and the Duck?



What do you see at first an old lady or a young woman?

Do You See a Vase, or Something More?



Find the Secret Message Hint: Look at the White.