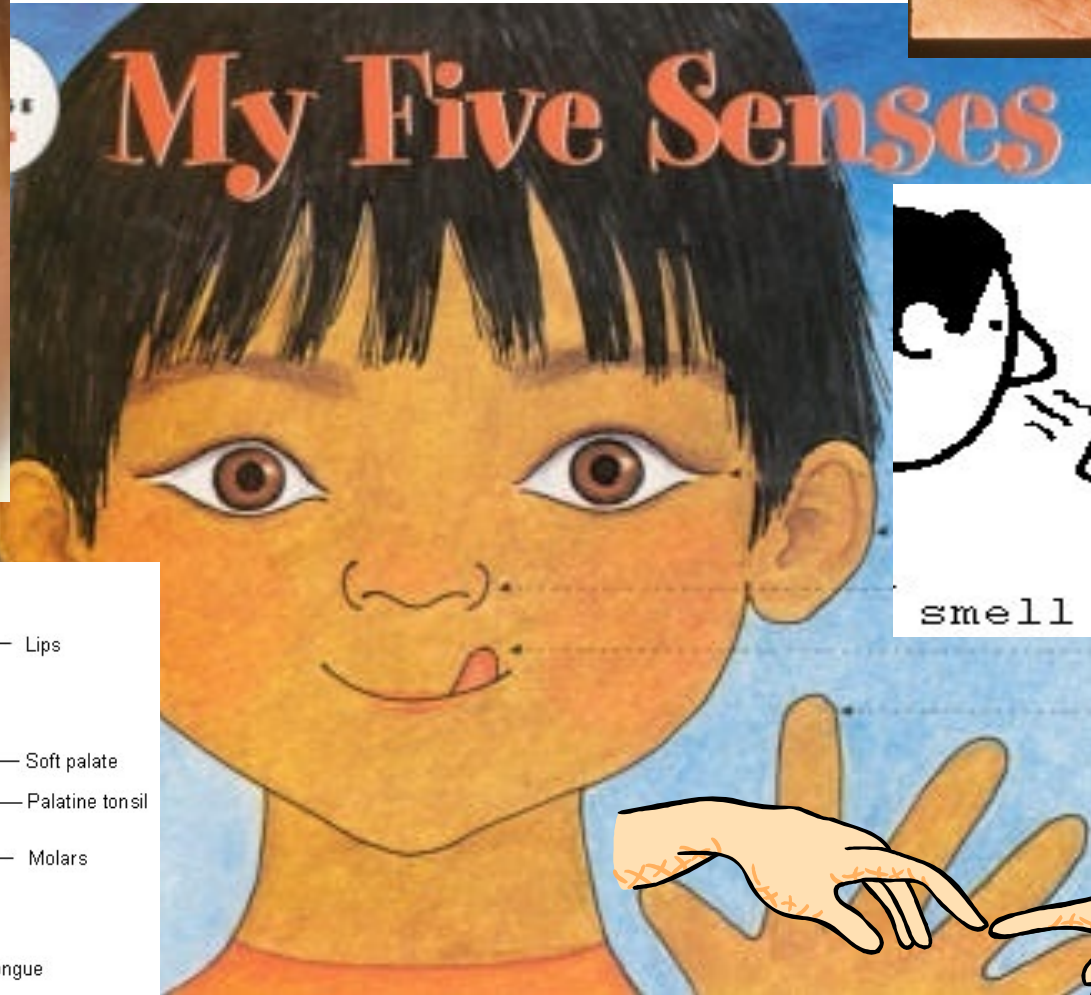
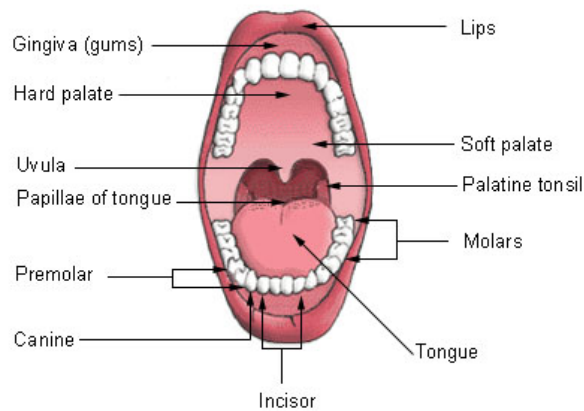


# Senses



## Mouth (Oral Cavity)



# Sensory organs

Sensory organs have specific sensory receptors that allow them to pick up and respond to different types of stimuli and then convert them to electrical impulses to be carried to the CNS for processing.

eyes

Light energy



nose

Chemical energy



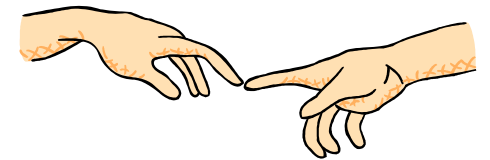
ears

Sound energy



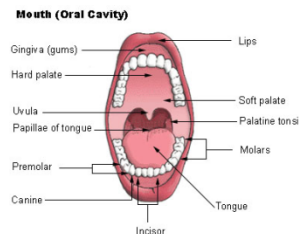
skin

Mechanical energy and heat energy



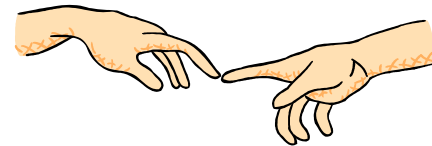
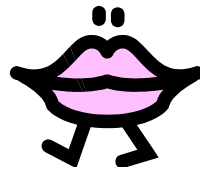
tongue

chemical energy



# Sensory Receptors

- **Supply the central nervous system with information about the environment (internal and external)**
- **Different receptors for different senses**
  - Smell, hearing, taste, sight and touch



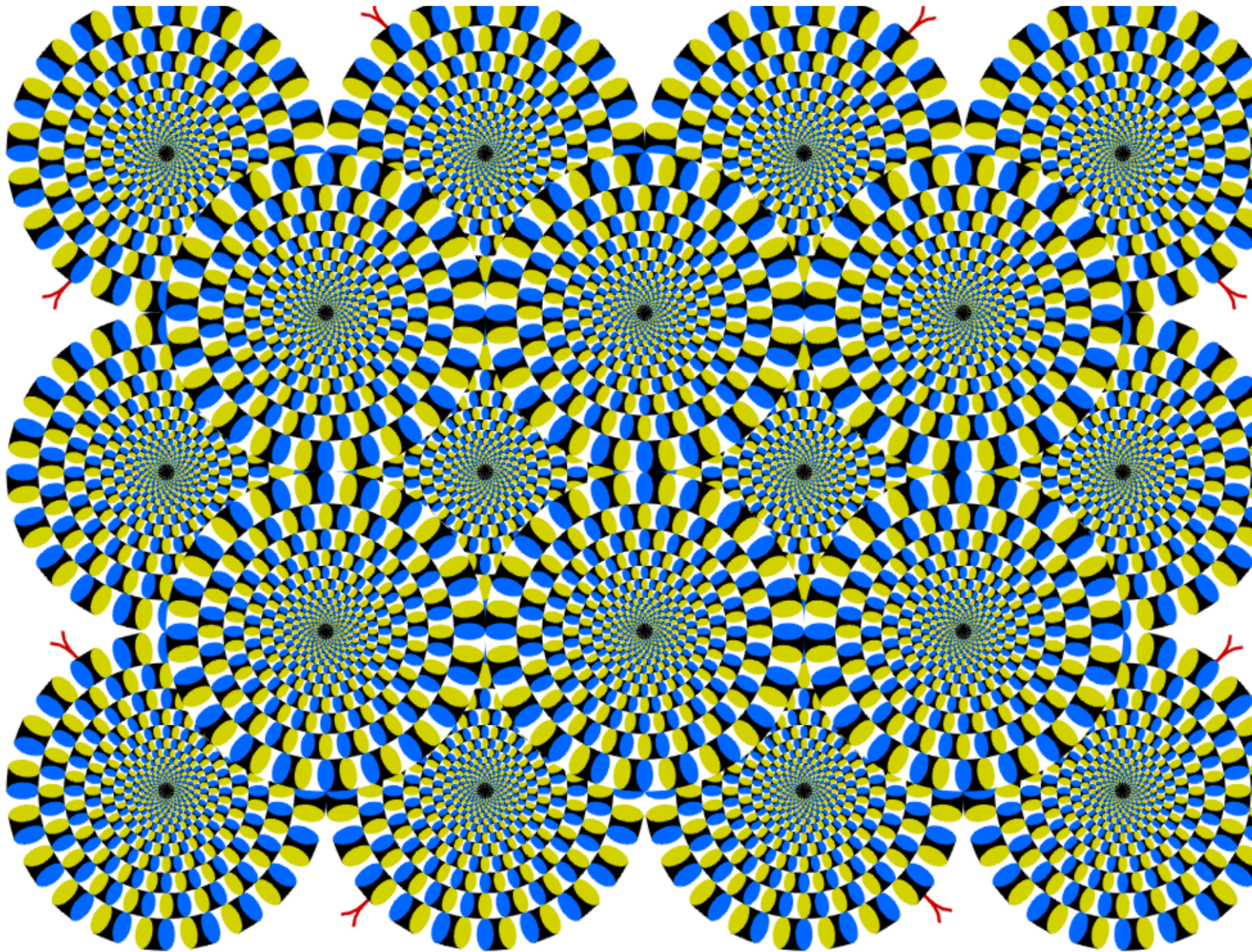
**Bozeman: Sensory  
System 10:31**

<http://www.youtube.com/watch?v=TAzTFgPSPiU>

**Check this out....**

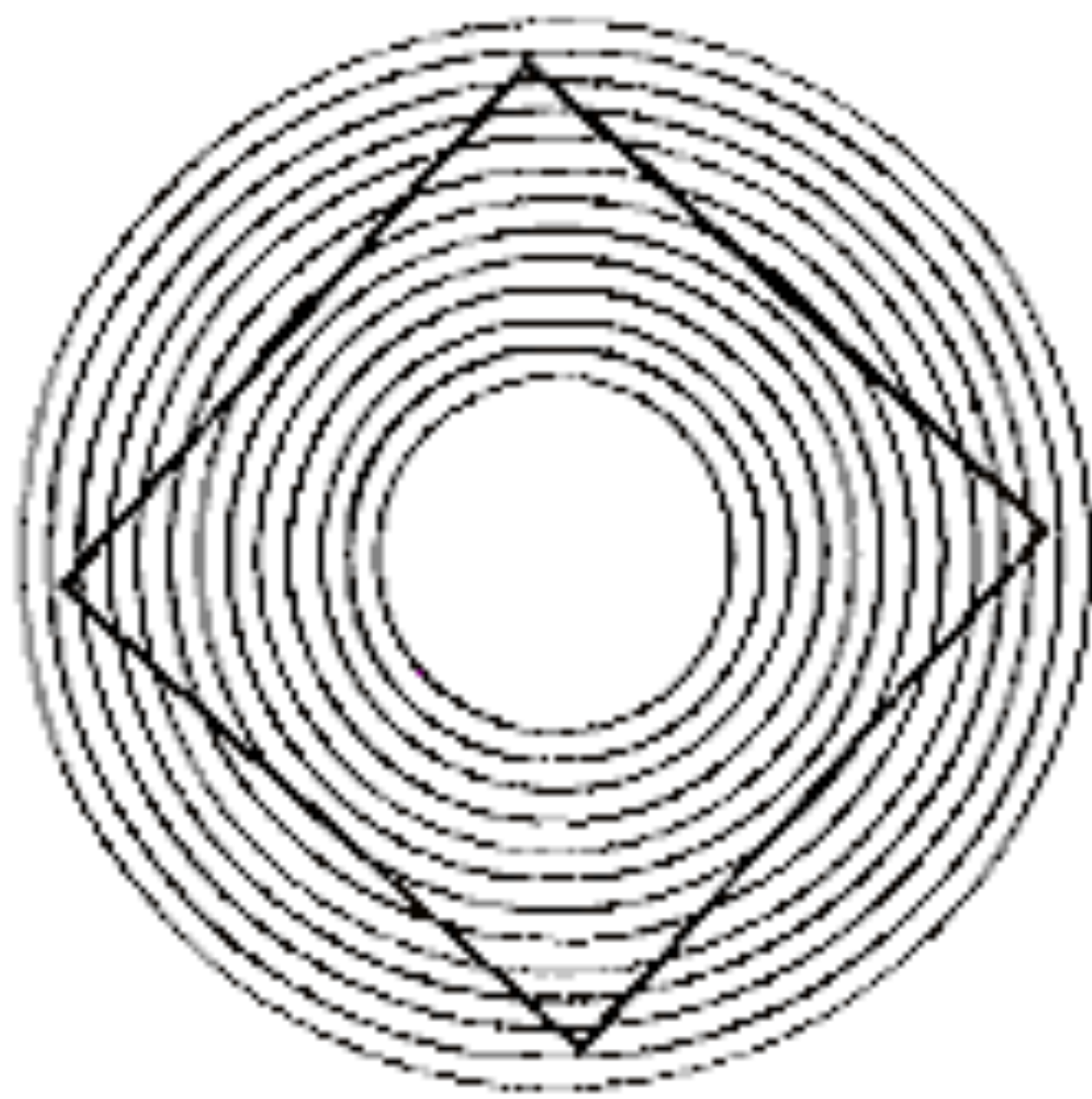


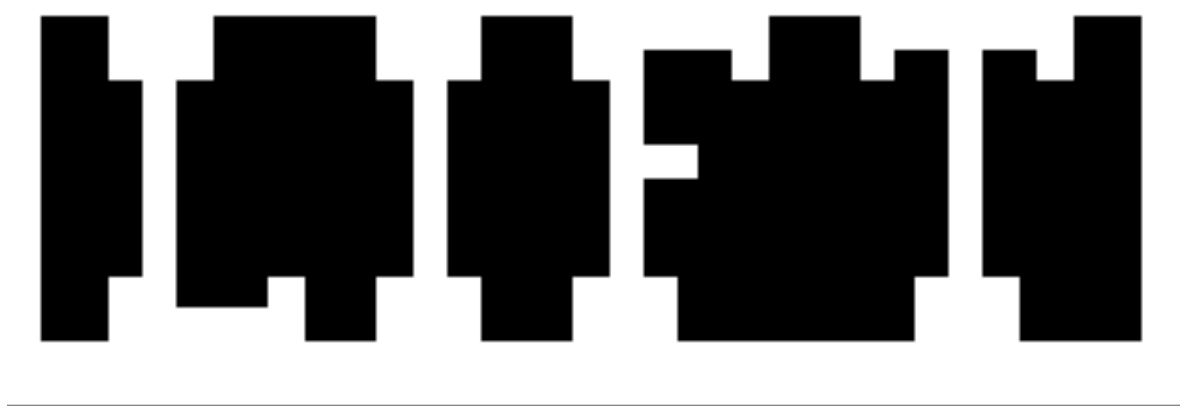
[Go to the Exploratorium to see some more cool illusions!](#)

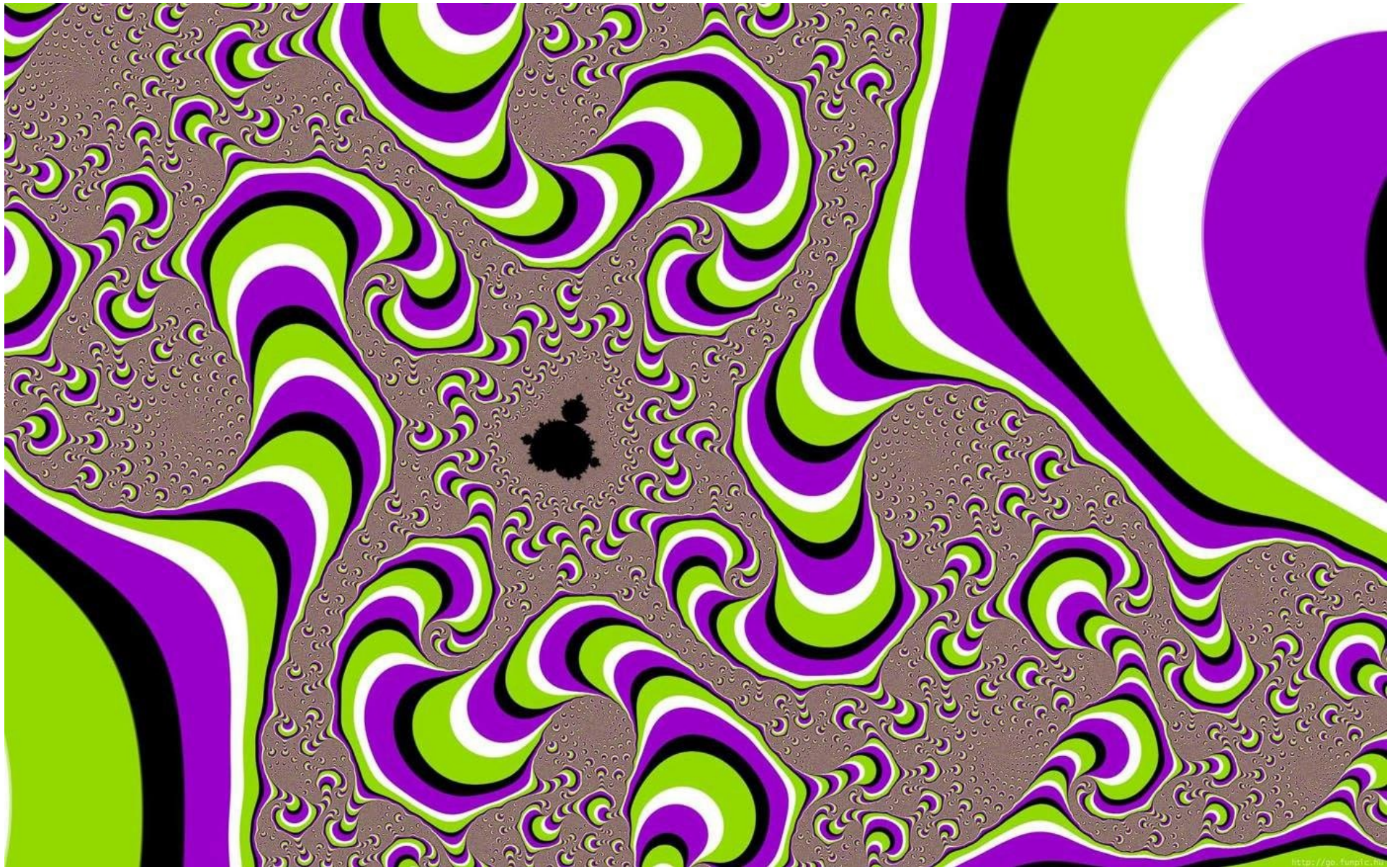












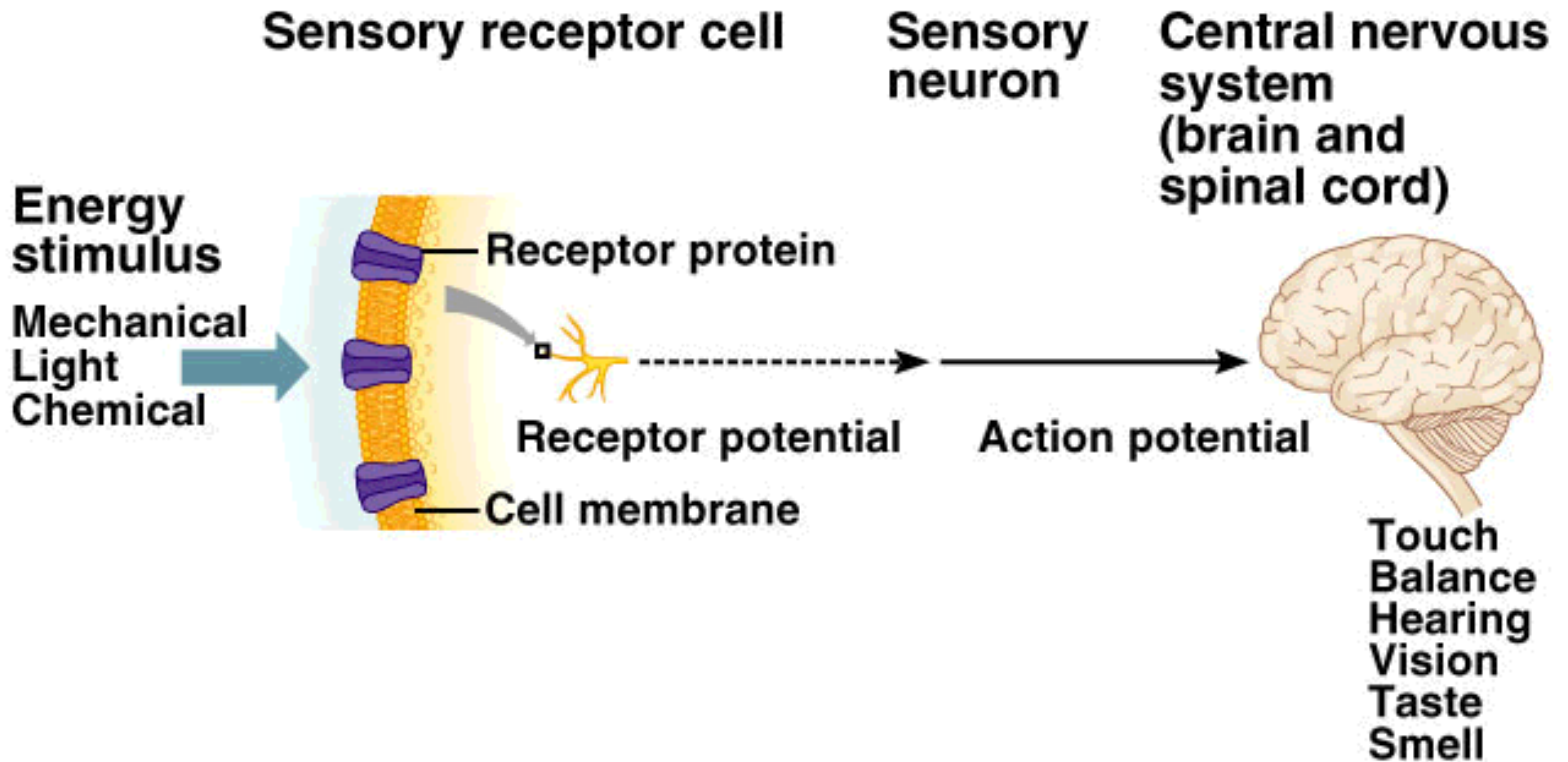
# Charlie Chaplin Hollow Mask Illusion

[http://www.youtube.com/watch?  
v=QbKw0\\_v2clo&safety\\_mode=true](http://www.youtube.com/watch?v=QbKw0_v2clo&safety_mode=true)

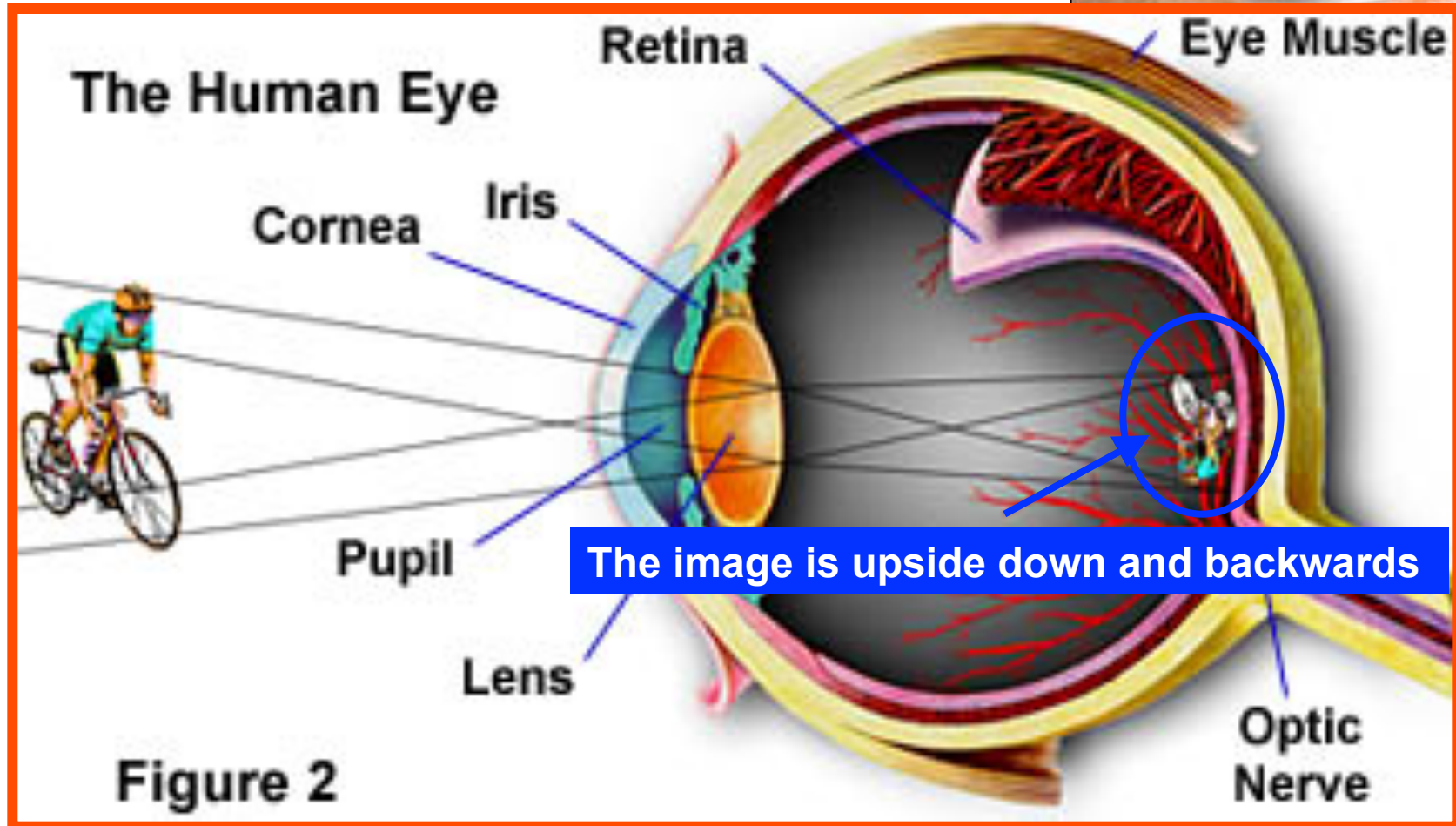
## **More Illusions:**

<http://youramazingbrain.org/>

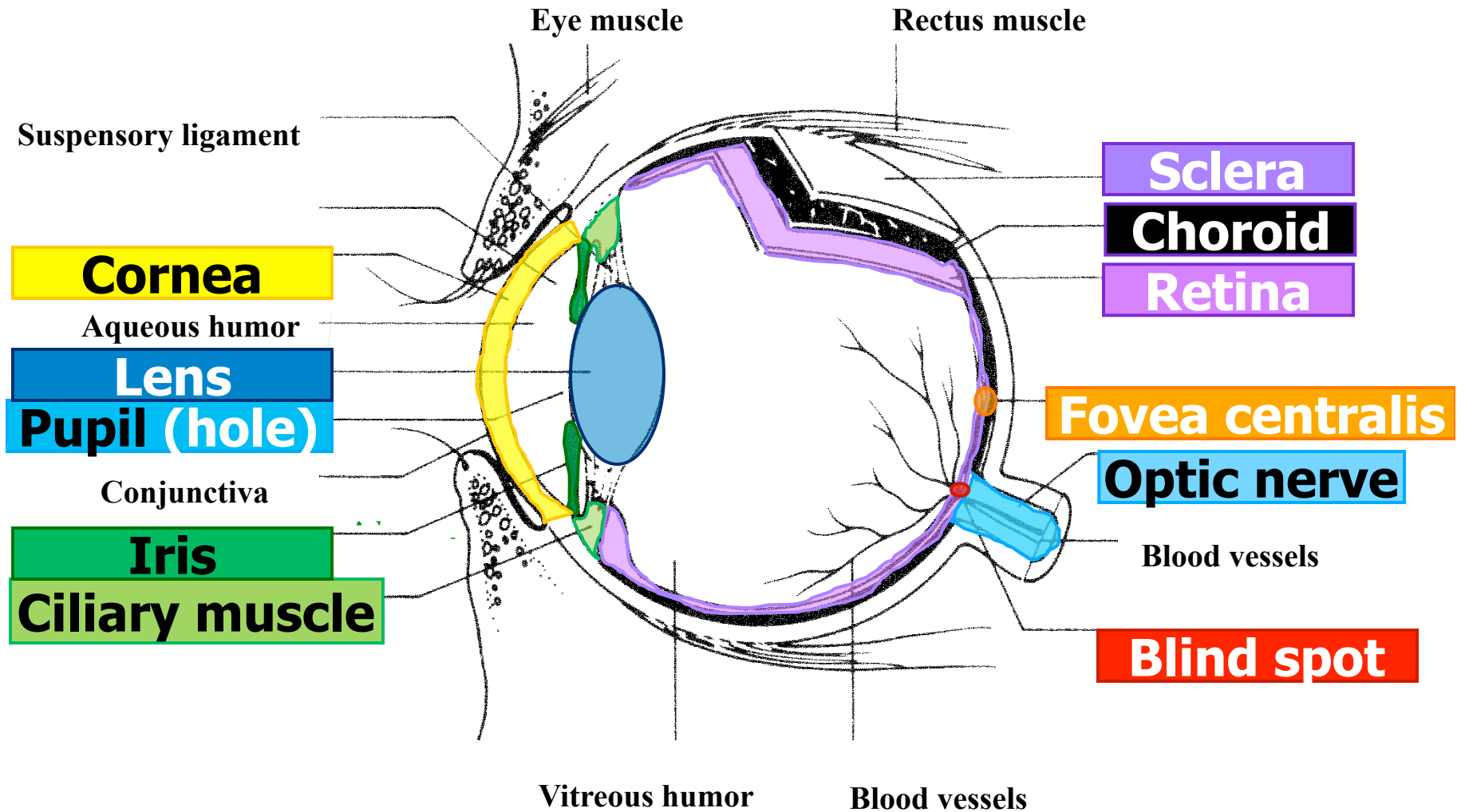
# Information Flow in Senses



# The Human Eye



# The Eye



Bozeman: Sensory System 10:31  
The eye starts at 5:30

<http://www.youtube.com/watch?v=TAzTFgPSP1iU>

# Sclera and Cornea (outer layer)



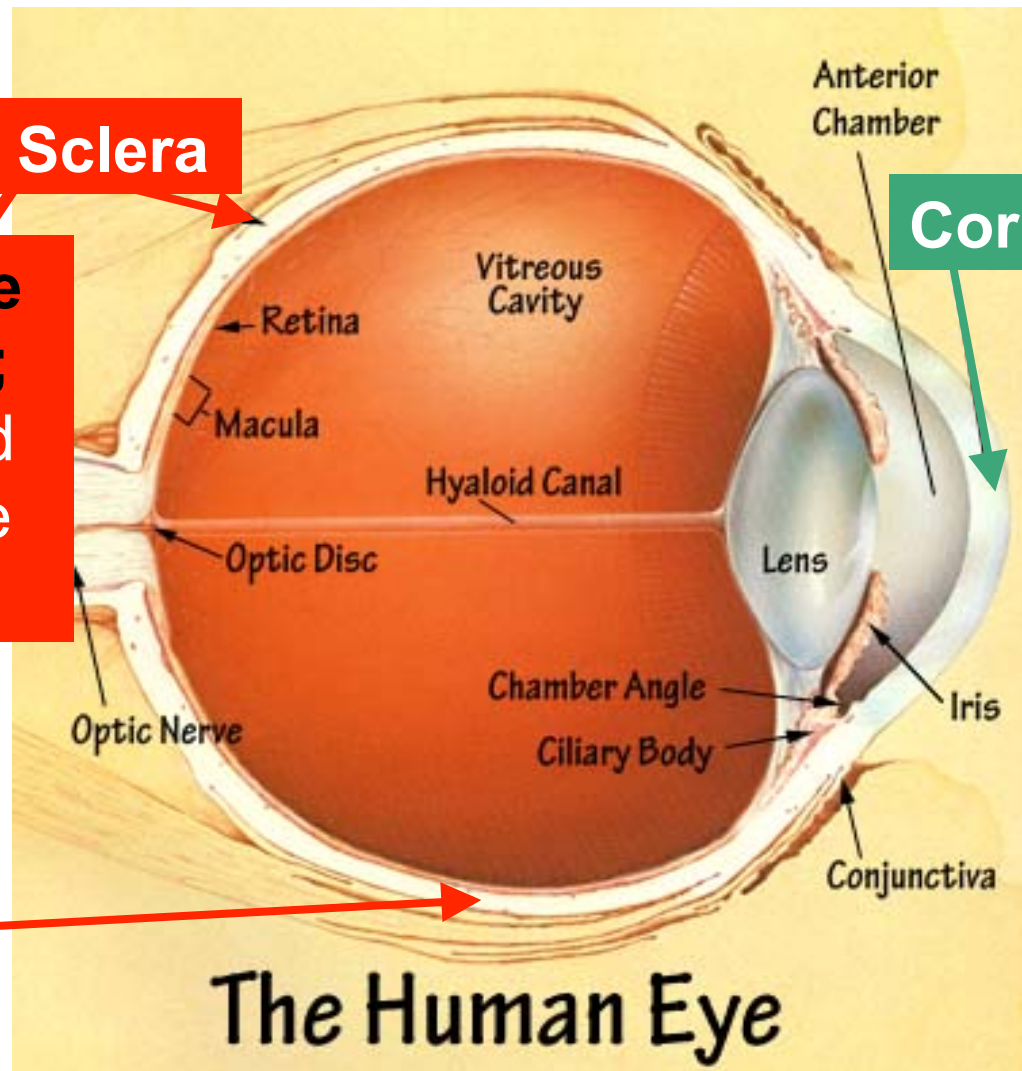
**Sclera**

**Tough, white outer layer;**  
Protects and supports the eye

**Cornea**

**Tough, clear outer layer;**  
Refracts (bends) light toward the pupil

**Sclera**



# Check these out!!

## **An Excellent Tour of the Eye**

<https://www.wisc-online.com/learn/natural-science/life-science/ap14304/the-sense-of-sight>

**THESE BIOLOGY AND  
CHEMISTRY JOKES**

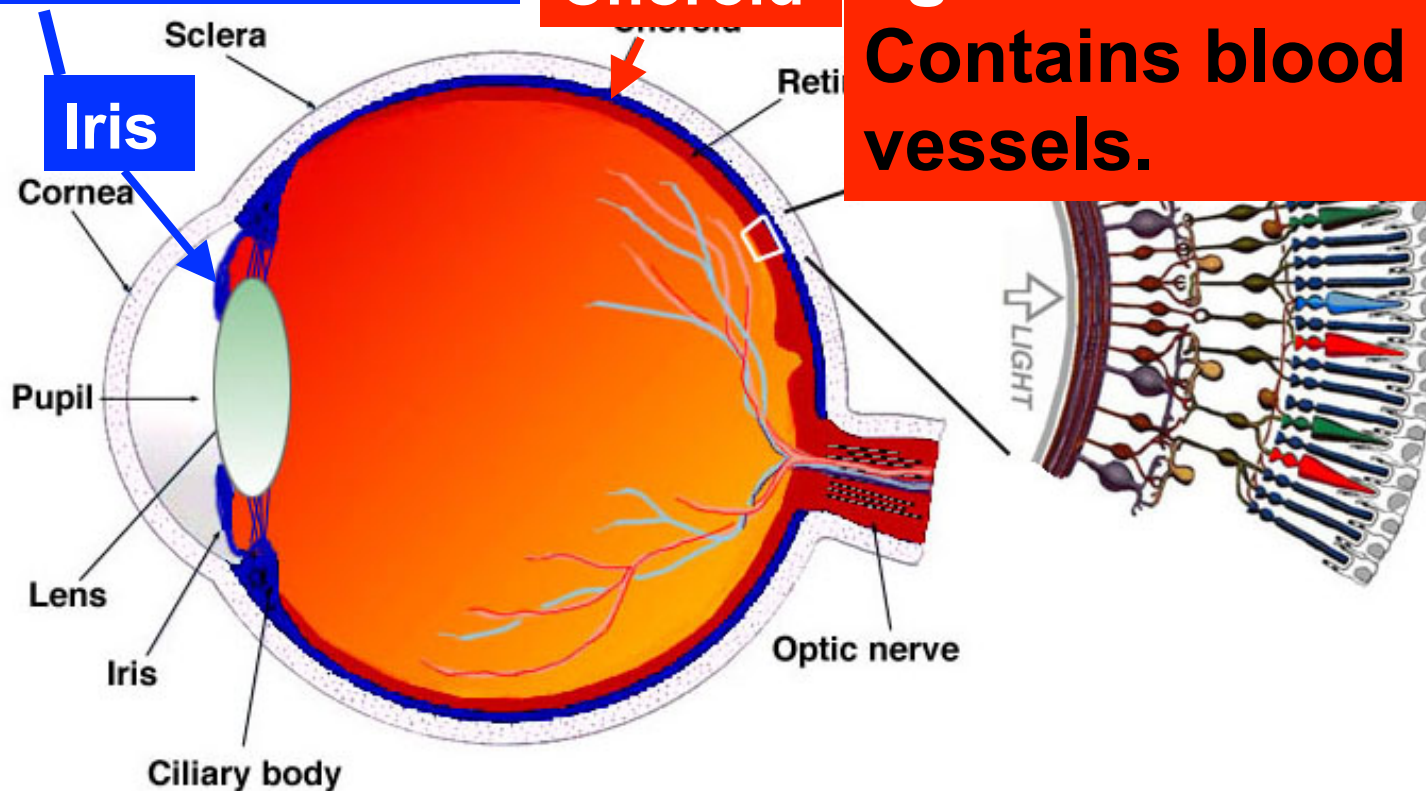
**KEEP GETTING CORNEA  
AND CORNEA**

# Choroid layer (middle layer) and the iris



**Pigmented muscle,  
controls pupil size**

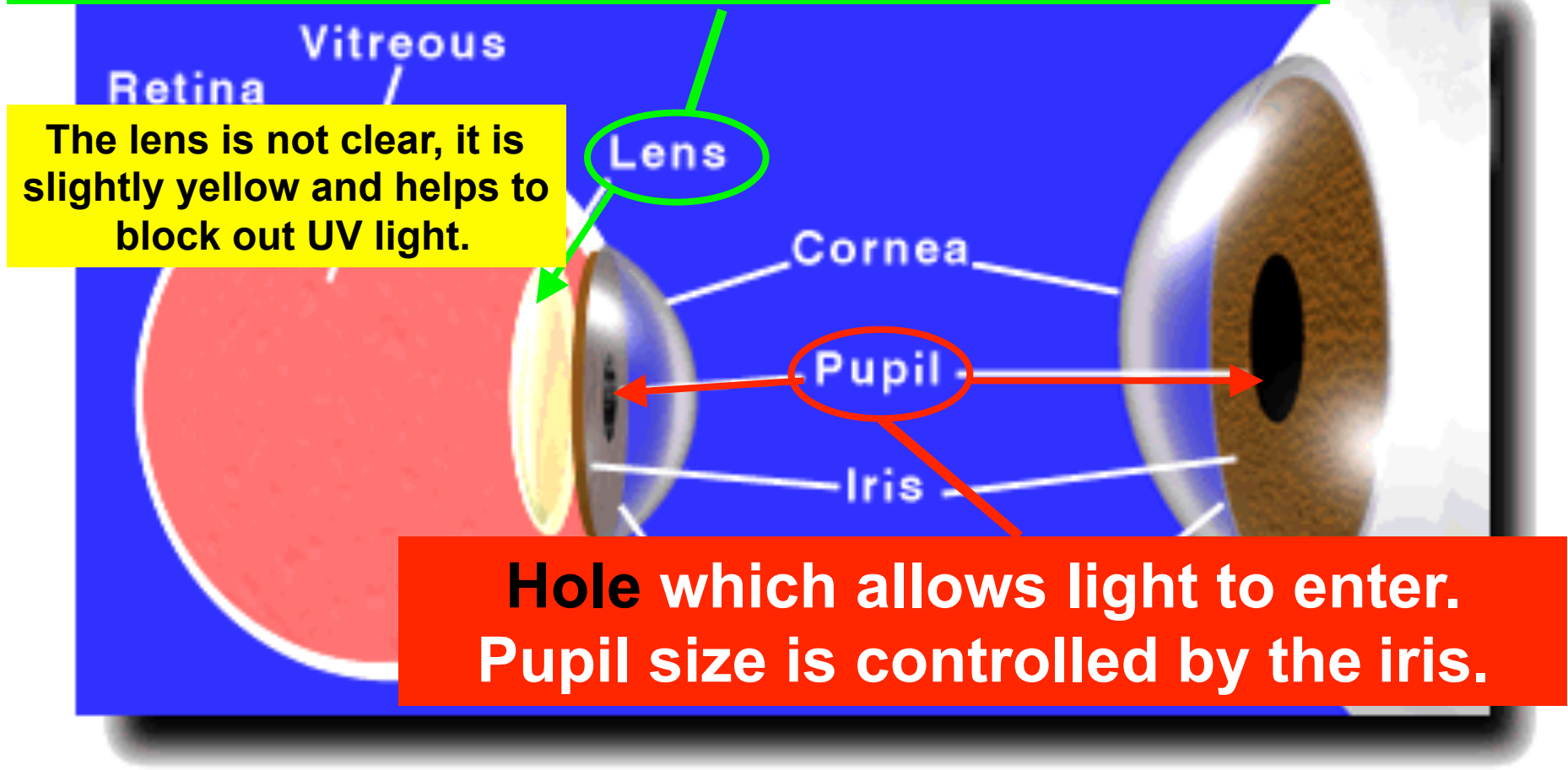
**Black layer, prevents  
light from scattering.  
Contains blood  
vessels.**



# Pupil and lens



Focuses images on the retina by **changing shape** (called accommodation)

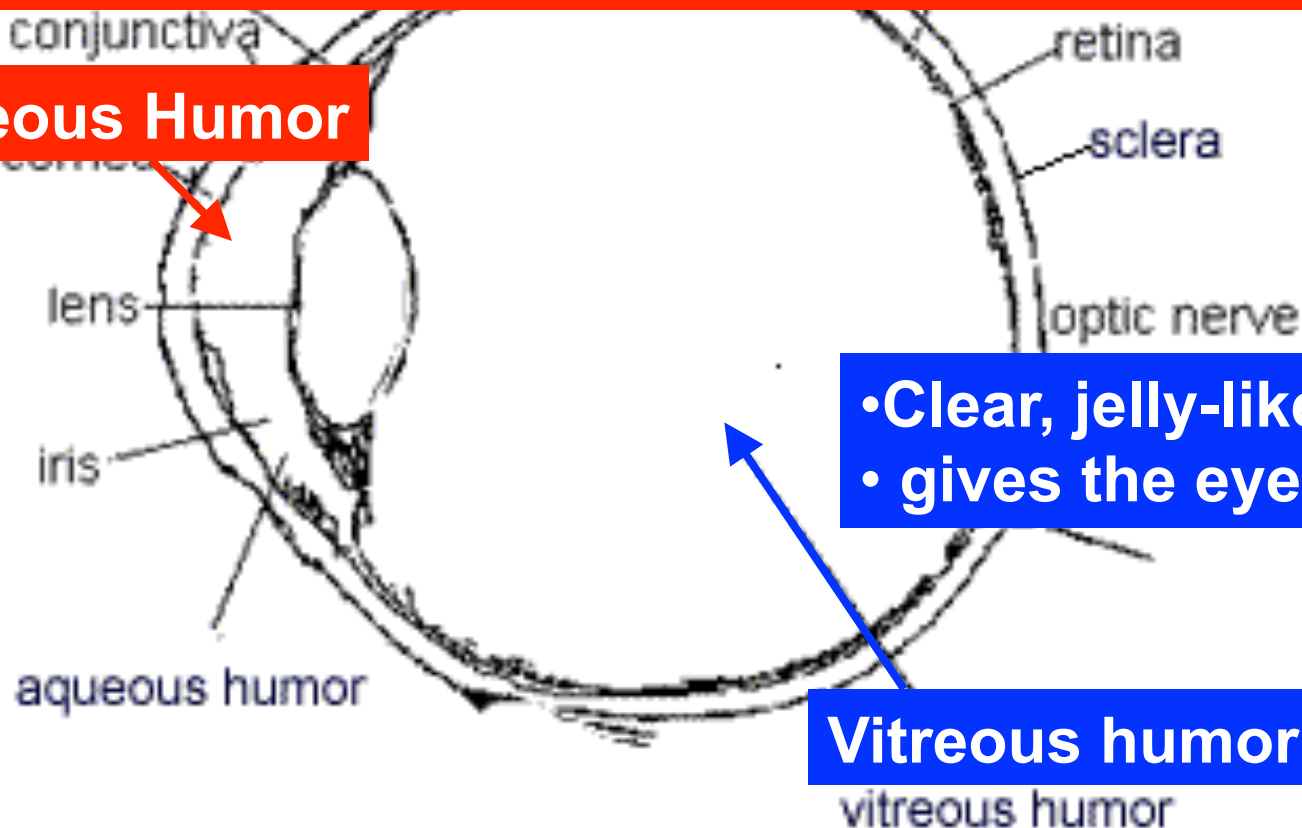


# Aqueous Humor and Vitreous Body



**Watery** fluid in the anterior chamber. It supplies the cornea and lens with **nutrients**, and maintains shape.

**Aqueous Humor**



- Clear, jelly-like fluid
- gives the eye structure

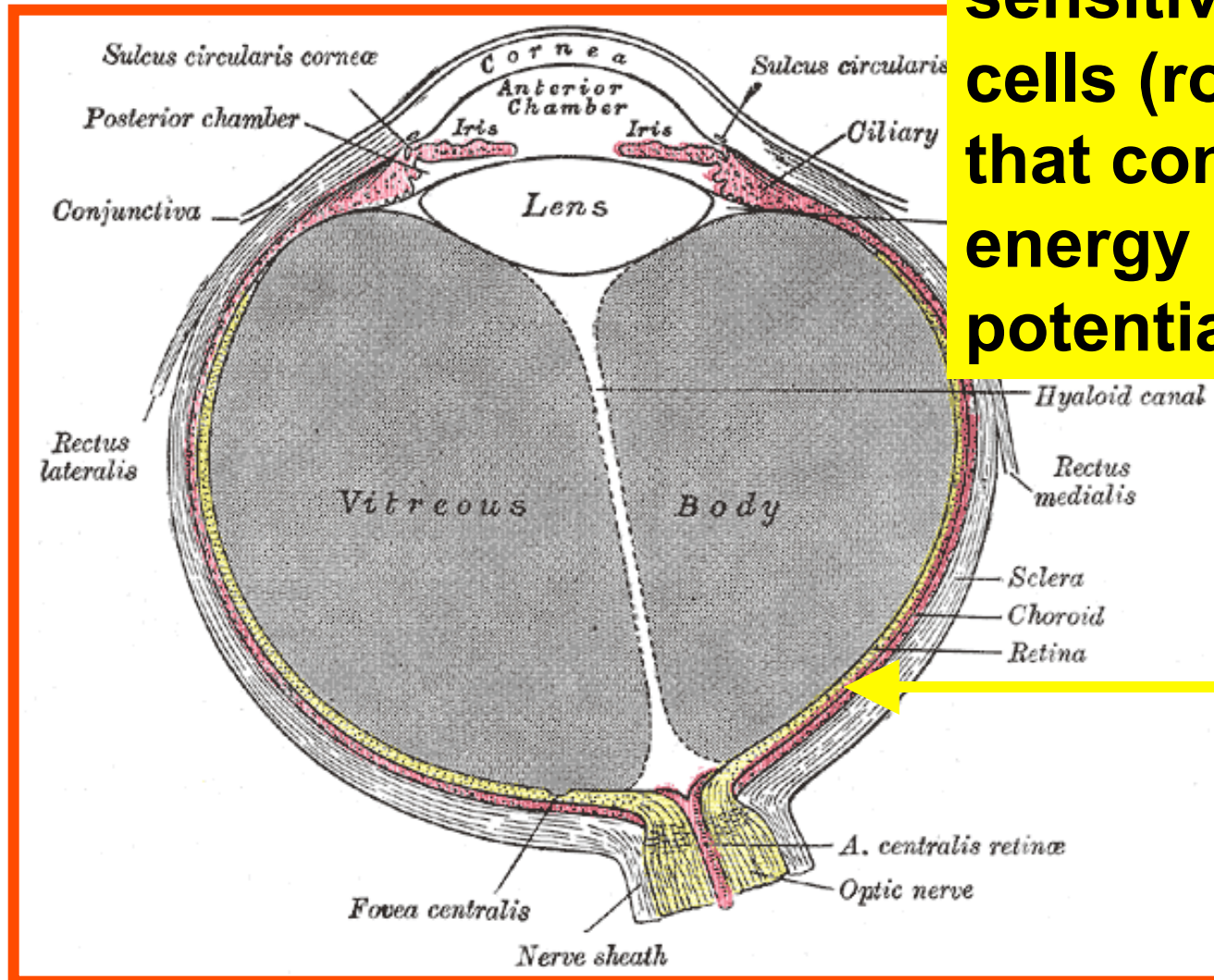
**Vitreous humor**

vitreous humor

# The Retina (inner most layer)

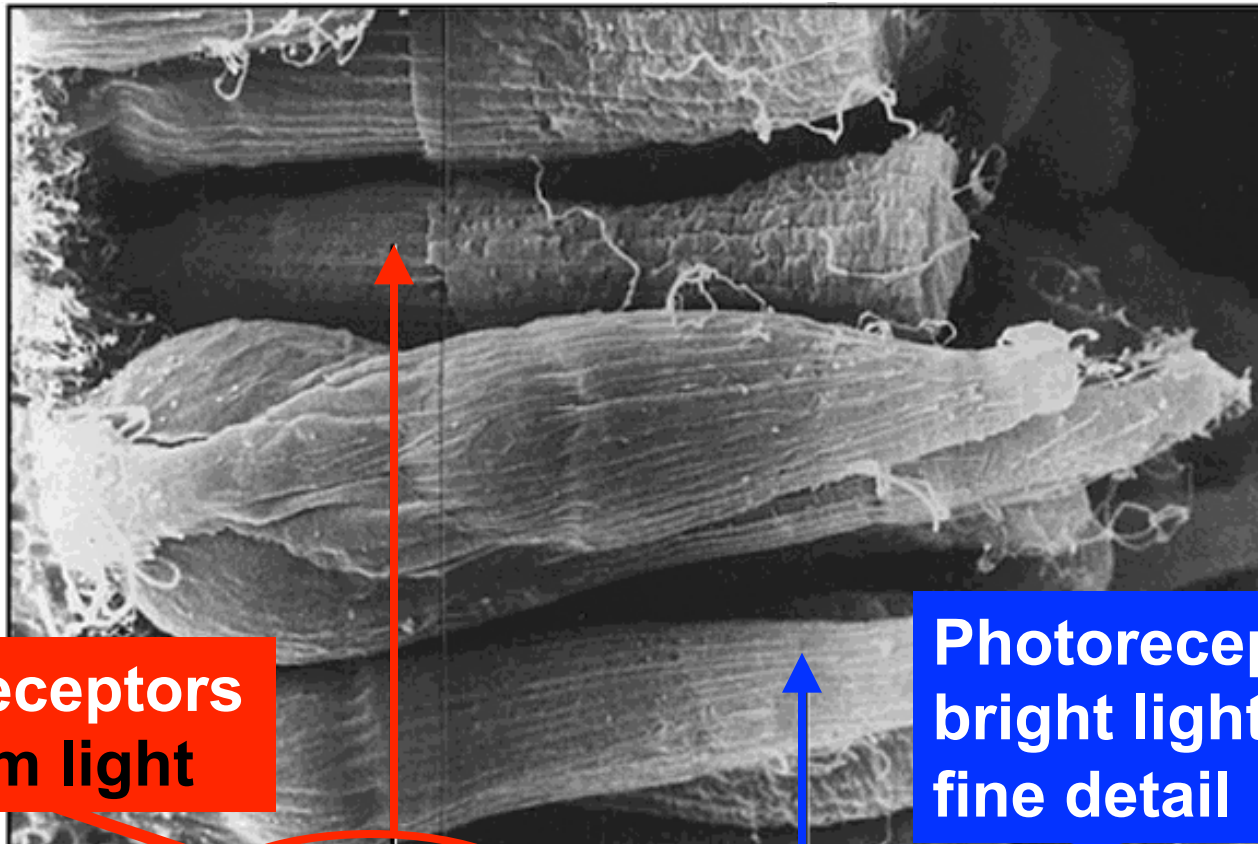


**Contains light sensitive cells (rods and cones) that convert light energy into action potentials.**



**Retina**

# Rods and Cones



**Photoreceptors  
for dim light**

**C**

**Rod cell**

**Cone cell**

**Photoreceptors for  
bright light, **color** and  
fine detail**

# Do animals have rods and cones?



- Hawks have 600 million rods in the center of their retina
  - This means their eyesight is **8X better** than humans
- Chickens on the other hand **only have cones**
  - So can chickens see at night?



- How about nocturnal predators like the owl, do they have more cones or rods?
  - » Cats and owls also have a **tapetum** which allows them to reflect light onto the retina even better

# After images

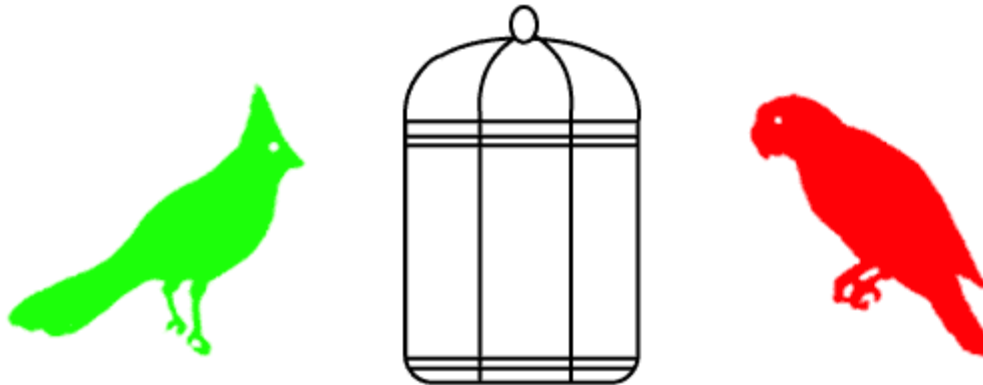
**Stare at the following picture for 15 seconds!**



**Now stare at the white background!**

**A negative after image is caused by the fatigue of a particular type of cone in that area of the retina.**

**Stare at the red bird for 20 seconds,  
Now stare at the empty cage!**



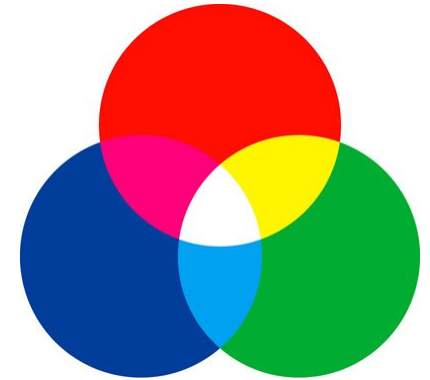
# Did you take your vitamin A?



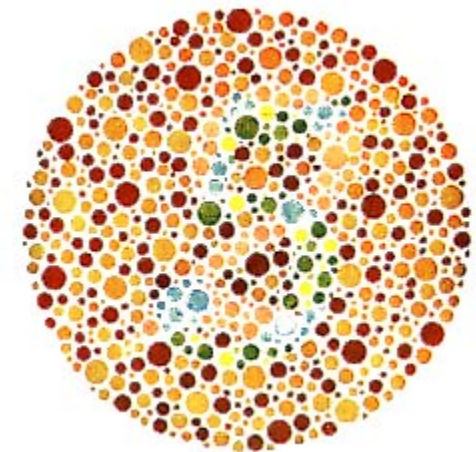
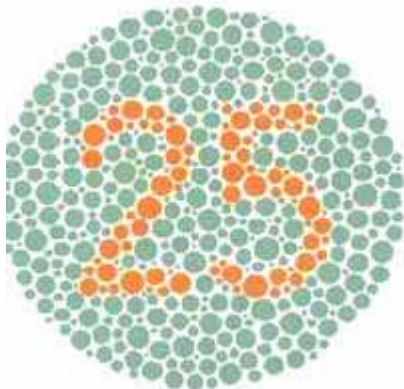
- **Vitamin A** is essential to rhodopsin, an important pigment found in rods
- **Vitamin A** is also an essential component to **red**, **blue** and **green** pigments found in cones
  - **Yellow** is produced by stimulating **red** and **green** cones
  - **Purple** is produced by stimulating **green** and **blue** cones
  - **White** is produced by stimulating **all** the cones equally



# Color blindness



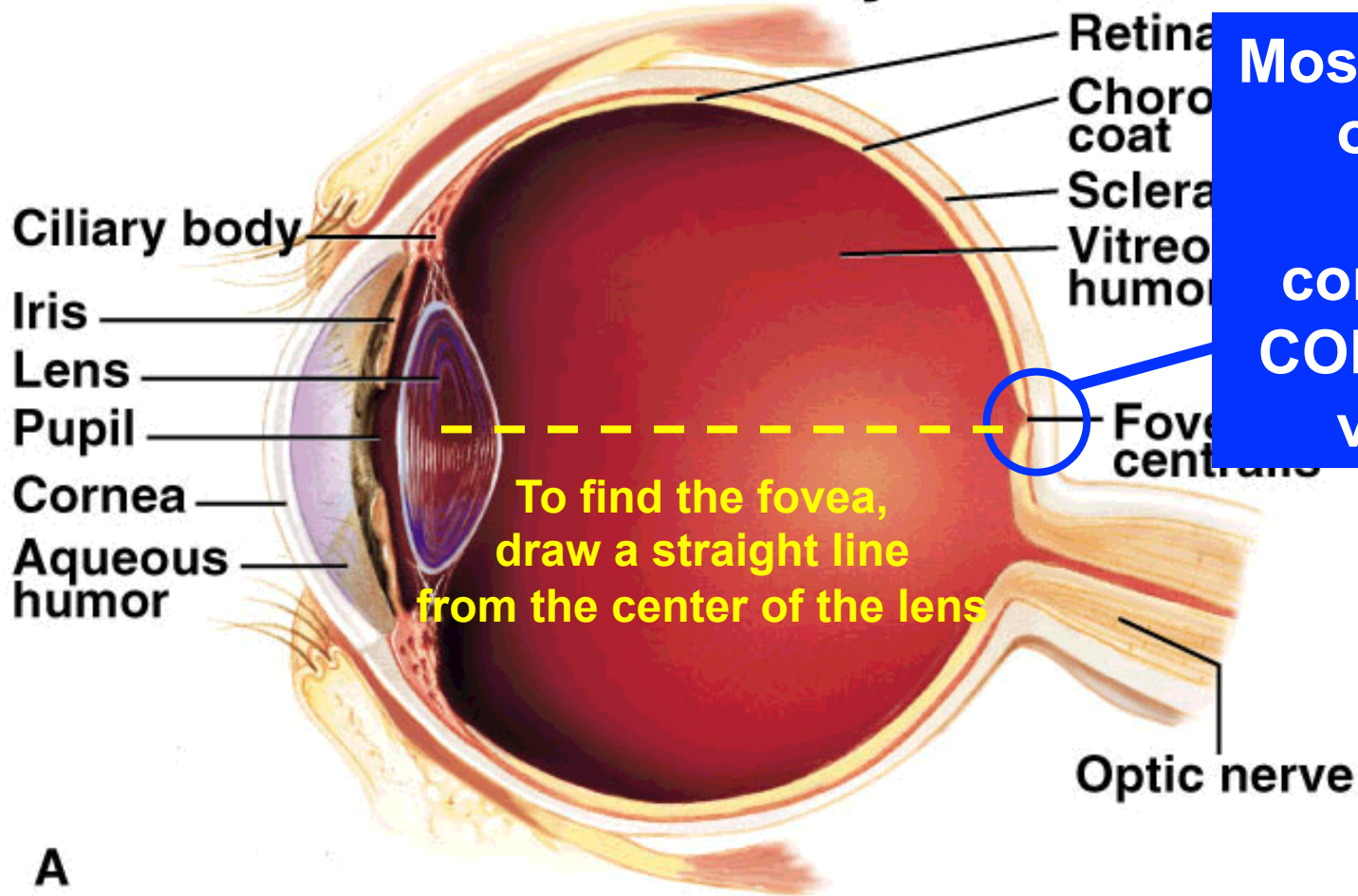
- Color blindness occurs when **one or more cones** are defective
- **Red-green** color blindness is most common
- Caused by a genetic defect on the X chromosome



# Fovea centralis (macula)



## Vertebrate eye



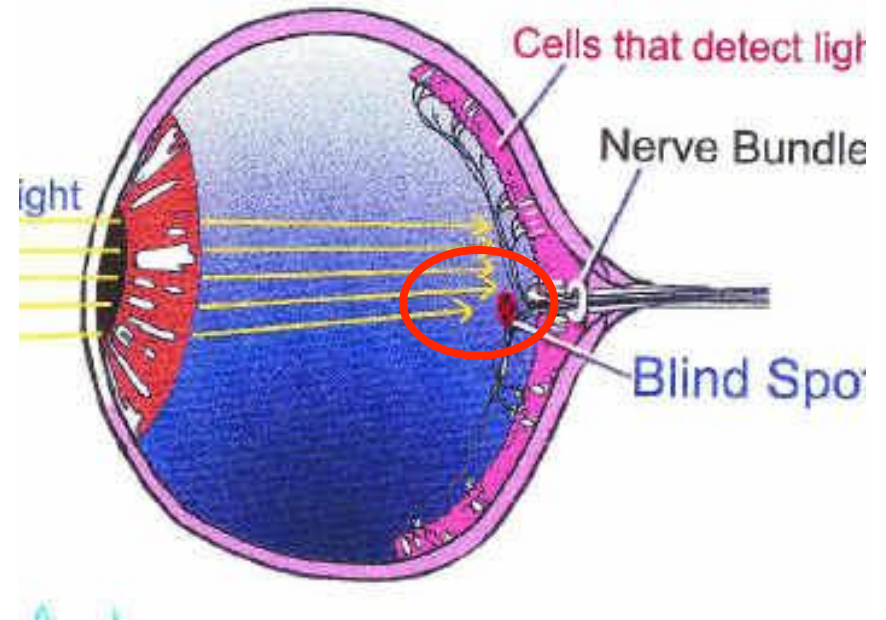
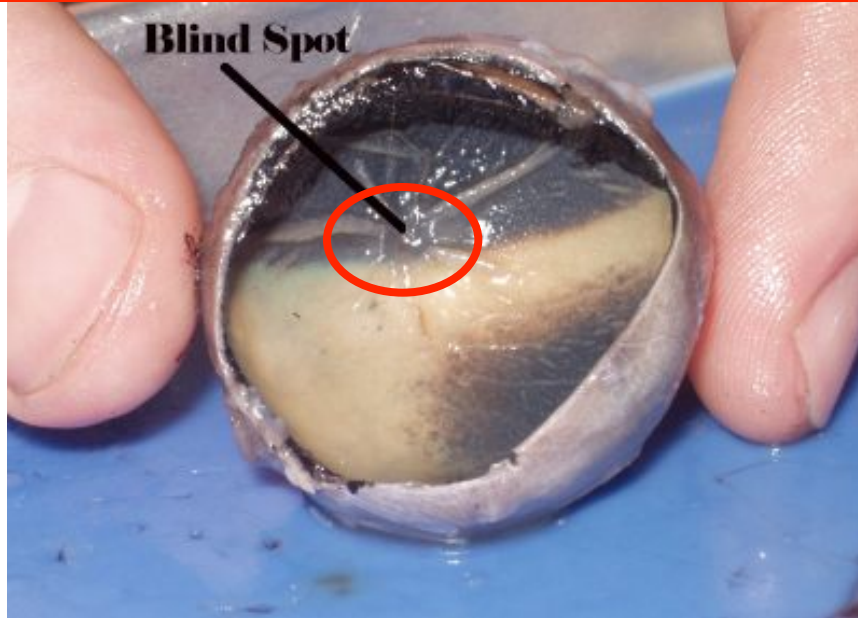
**Most sensitive area  
of the retina,  
highest  
concentration of  
CONES = greatest  
visual acuity**

**To find the fovea,  
draw a straight line  
from the center of the lens**

# Blind Spot



Where the retina attaches to the optic nerve. There are **NO rods or cones** in the blind spot

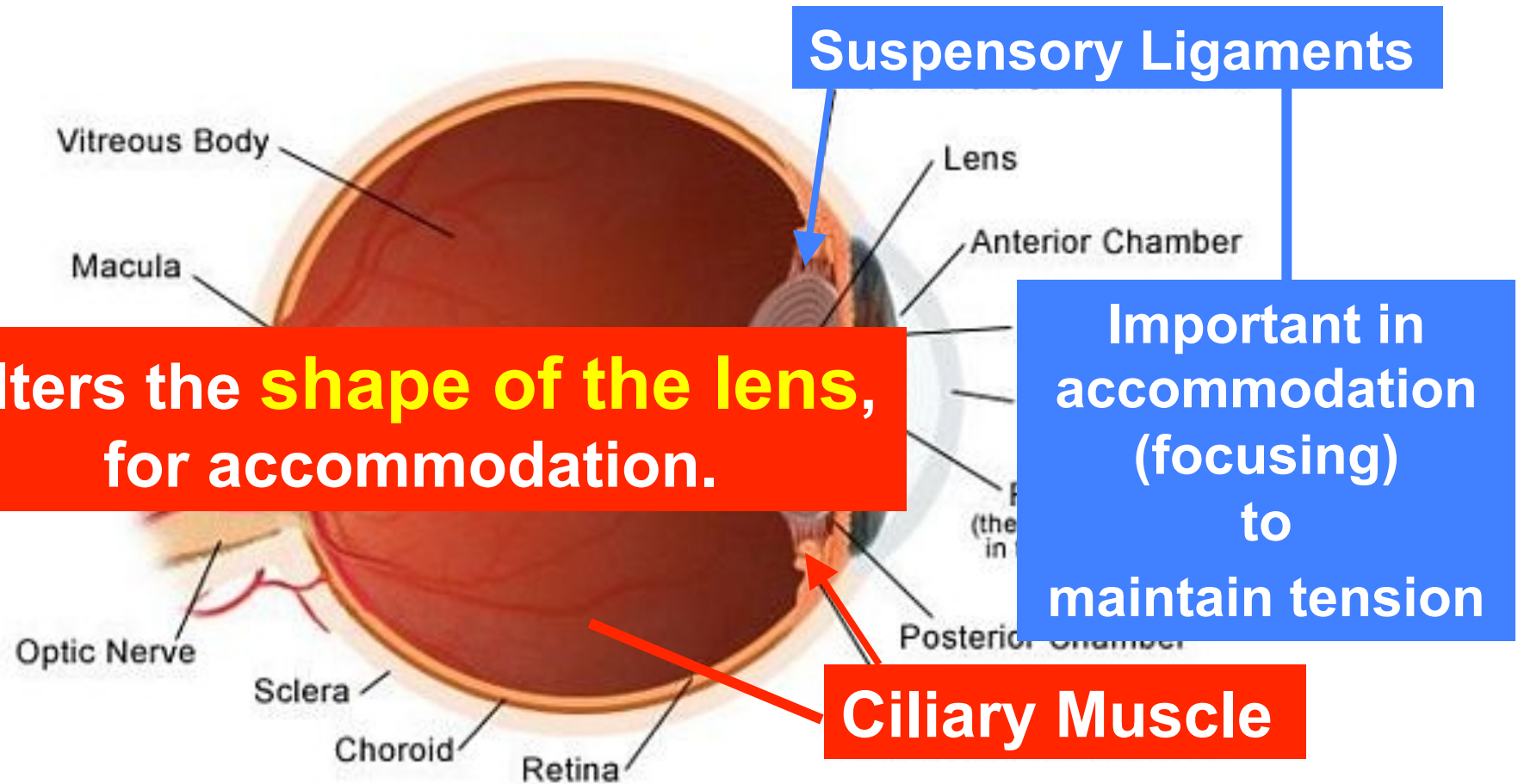


Optic nerve carries info to the occipital lobe

## Find Your Blind Spot

<https://visionaryeyecare.wordpress.com/2008/08/04/eye-test-find-your-blind-spot-in-each-eye/>

# Ciliary Muscle and Suspensory Ligaments



Suspensory Ligaments

Alters the **shape of the lens**,  
for accommodation.

Important in  
accommodation  
(focusing)  
to  
maintain tension

Ciliary Muscle

**Pink eye = infection of the conjunctiva**

Thin  
the  
pro

Bl

→  
**Eye Booger**

↑  
Itching, burning  
bloody eyes

↗  
Swelling like a black-eye  
punched in the face

Trabecular  
meshwork

Choroid

W

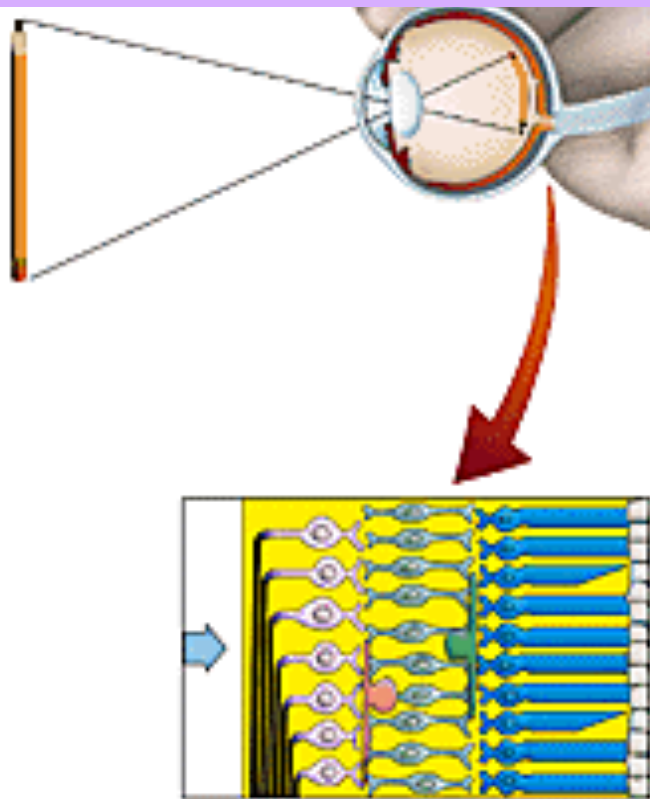
ptic  
erve

ous  
our

**The image is inverted**

**Thalamus**

**Occipital Lobe**



# Pathway of Light into Eye (and brain)

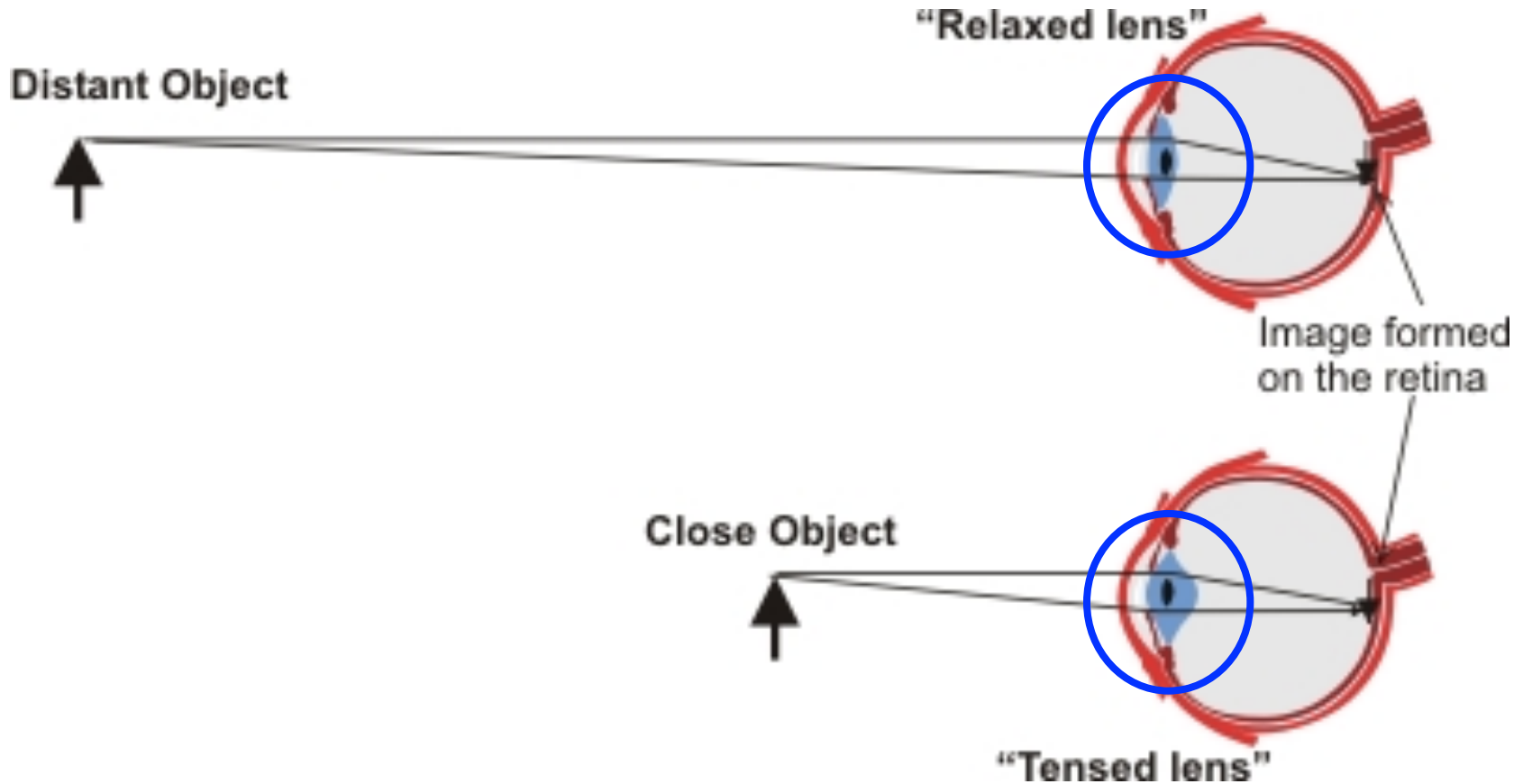
- Cornea
- Pupil (surrounded by iris)
- Lens
- Retina

**Optic Nerve**

**Occipital Lobe**

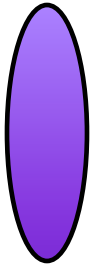
# Accommodation

Lens changes shape to focus.

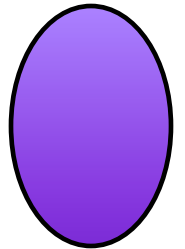


# accommodation

Flat lens: used to view far away objects

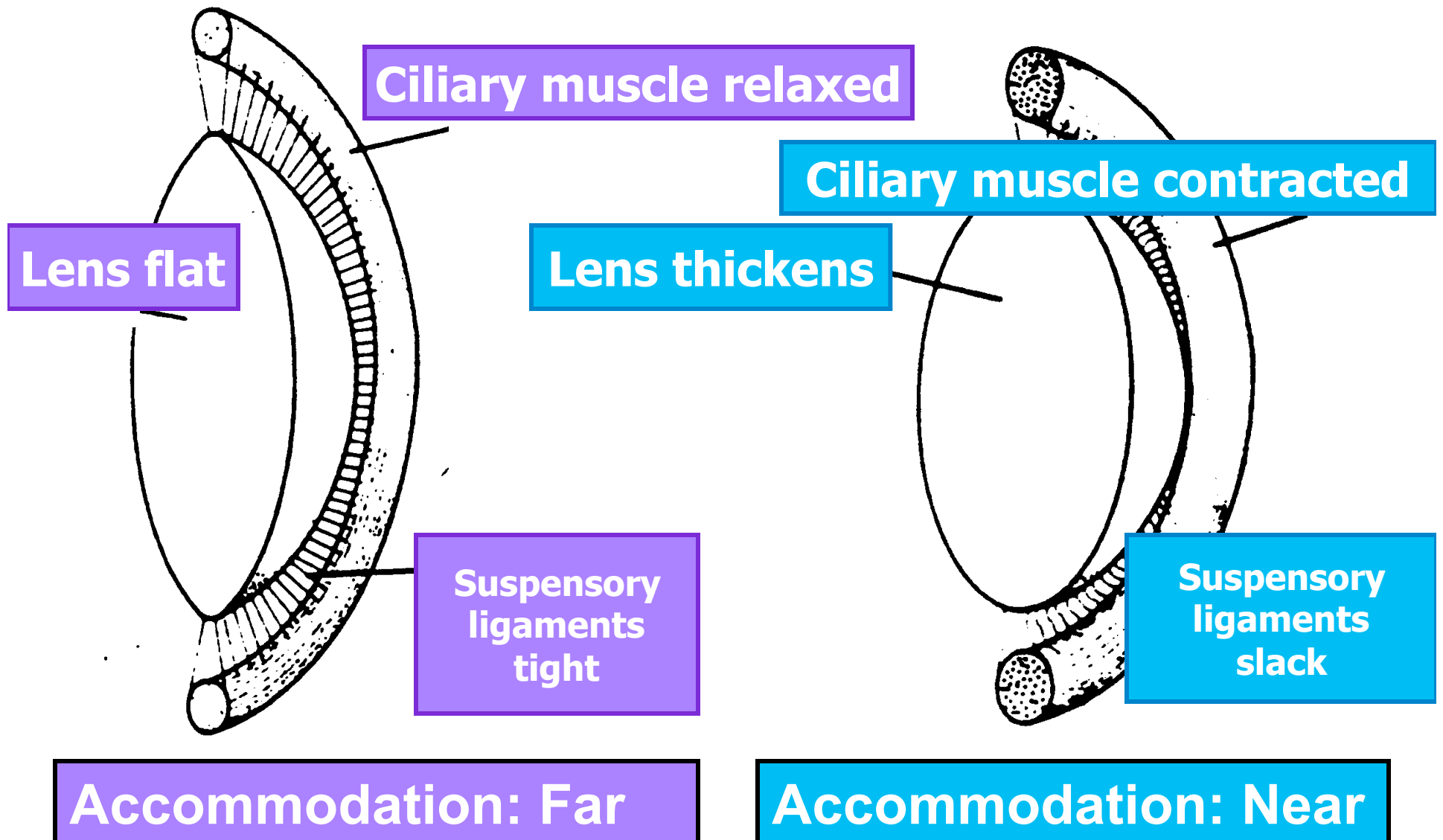


Thicker lens: used to view closer objects

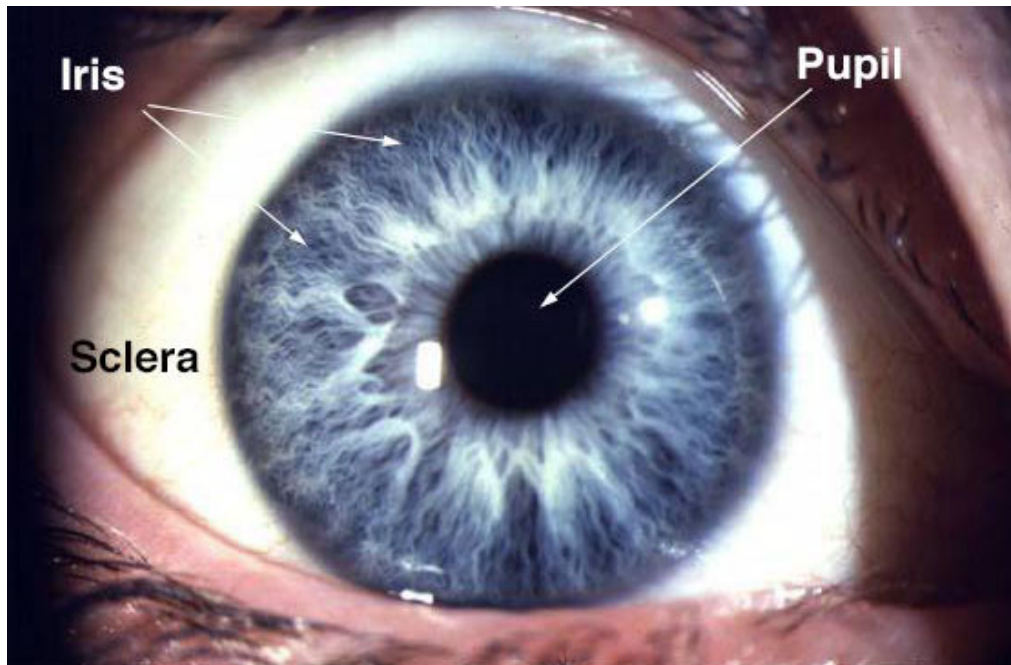


Accommodation is controlled by **ciliary muscles.**

# Accommodation (focusing)



# Accommodation and the pupil



## Far objects

- Pupils **dilate** to capture as much light as possible

## Close objects

- Pupils **constrict** to focus on the image

# Ever wondered how a camera works?

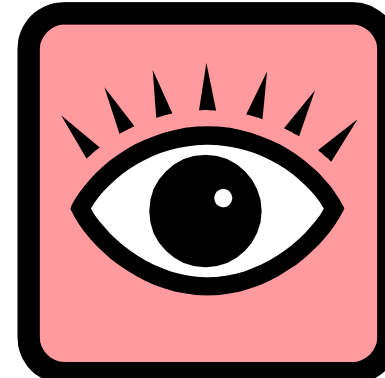
## Camera

- Case
- Lens
- Diaphragm
- Aperture
- Memory card



## Human Eye

- Retina
- Lens and cornea
- Sclera
- Pupil
- Iris

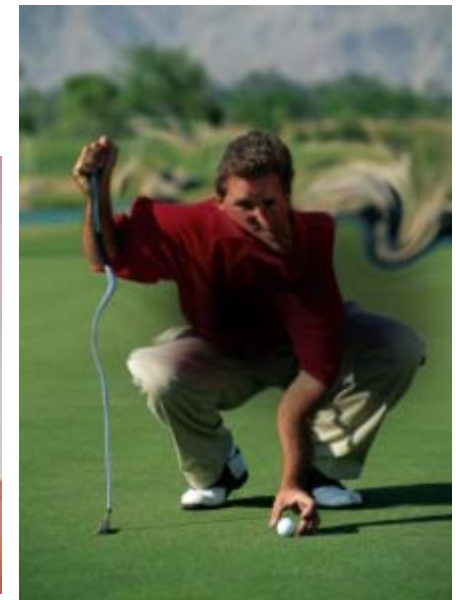


# Eye Quiz

1. **opening** in centre of eye pupil
2. contains **photoreceptor** retina
3. **controls shape** of lens ciliary muscle
4. photoreceptors for **night** vision rods
5. **Stimulus that initiates** nervous impulse (action potential) light
6. photoreceptors for **detailed vision** cones
7. release chemical transmitters **to ganglion cells** Bipolar cells
8. **carries nerve impulses** from eye to brain Optic nerve

9. spot where **optic nerve attaches** to retina Blind spot
10. **interprets** visual signals that have been sent from eye Occipital lobe
11. liquid **maintains eye shape** and nourishes cornea Aqueous humor
12. transparent portion of eye that **covers the front** **cornea**
13. **biconvex** elastic structure that can change shape and focuses light **lens**
14. colored **muscles** controlling amount of light entering eye **iris**
15. **tough protective** area of eye, no blood vessels **sclera**
16. in center of retina, contains a **lot of cones** **Fovea centralis or macula**

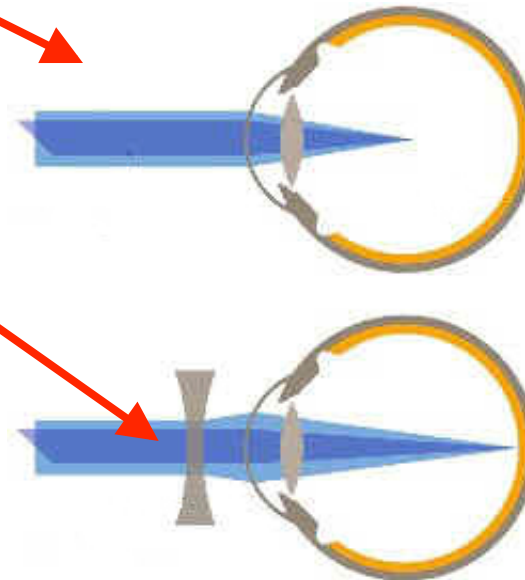
# Visual Defects



# Myopia (nearsightedness)



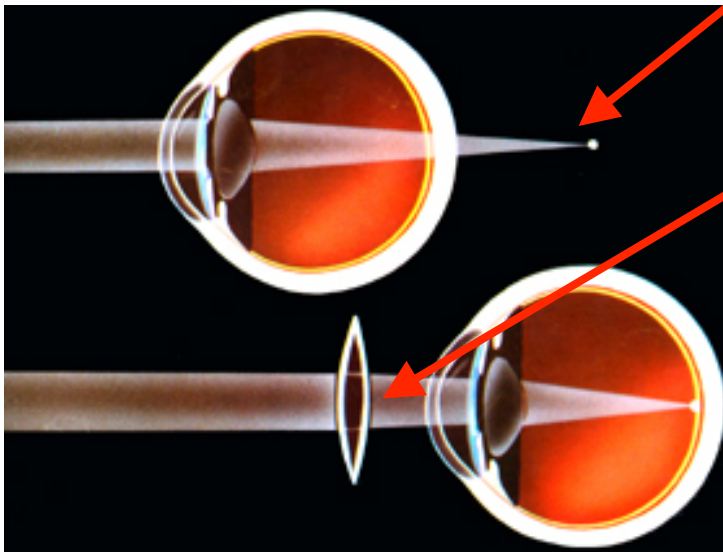
- Can you see near or far?
  - Near
- The eyeball is **too long**, so images are focused **in front** of the retina
- Corrected by a **concave** lens



# Hyperopia (farsightedness)



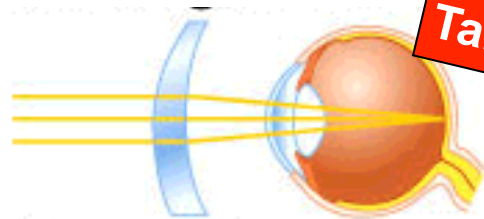
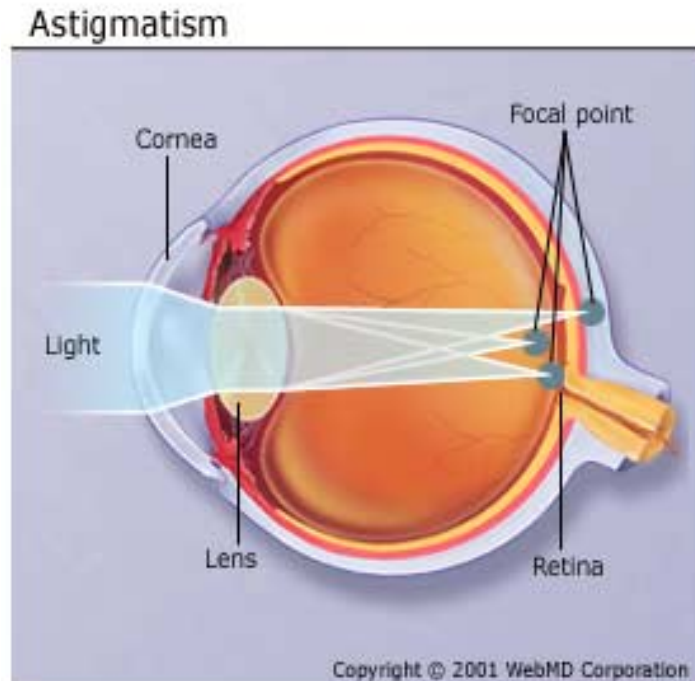
- Can you see near or far?
  - Far
- The eyeball is **too short**, so images are focused **behind** the retina
- Corrected by a **convex** lens



# Astigmatism



- The **lens or cornea** is **irregularly** shaped and light rays are focused at different points on the retina
- Result = **blurry vision**
- Corrected by an **uneven lens**

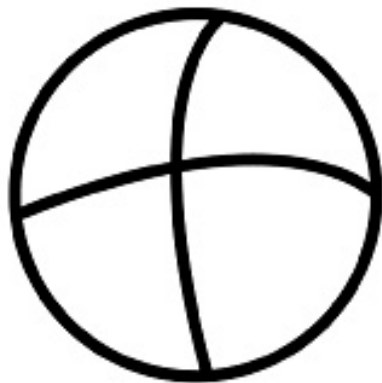


Uneven lens corrects astigmatism

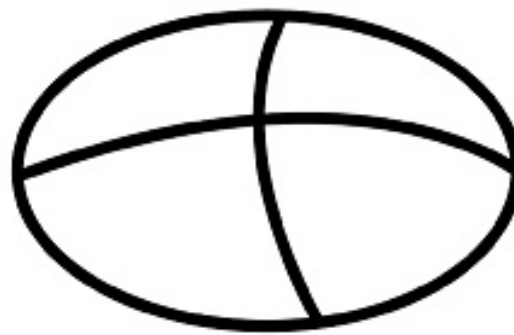
Take the astigmatism test!



Normal cornea



Cornea with astigmatism



Normal vision



Vision with astigmatism



# Glaucoma

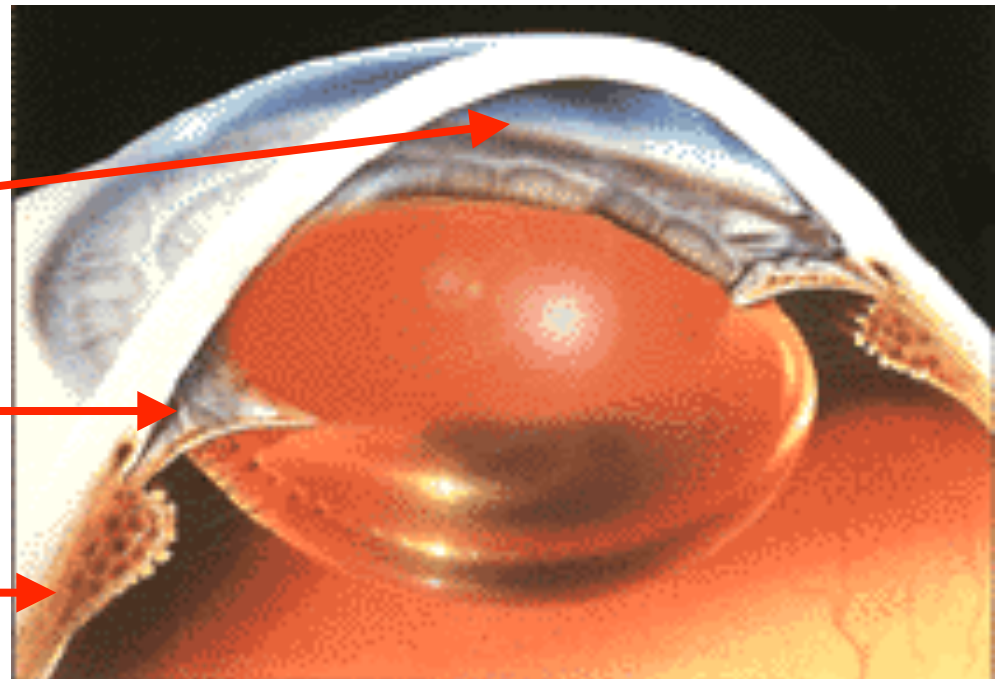


- Build up of **aqueous humor** in the anterior chamber of the eye due to overproduction by ciliary body
- **Canal of Schlemm** blocked and excess fluid builds up

**Anterior chamber**

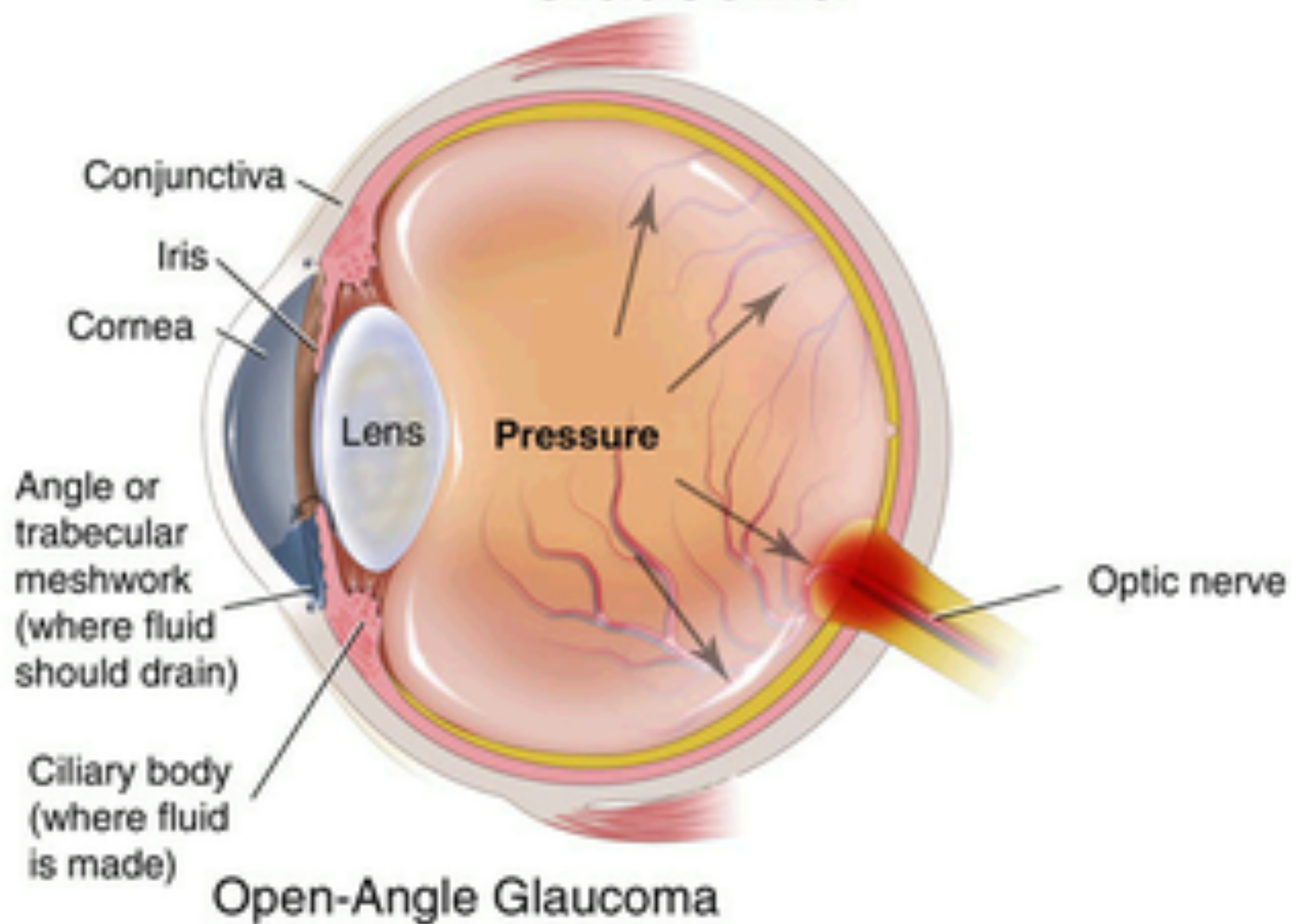
**Canal of Schlemm**

**Ciliary body**



<http://www.youtube.com/watch?v=IJwsBXGlf7c>

# Glaucoma



# Glaucoma



A gradual loss of side vision  
noticeable symptoms of gl



Blurred vision may be another  
symptom of glaucoma.



- **Excess pressure** builds up on the lens, vitreous and ultimately the retina
- **Blood vessels** collapse
- **Optic nerve** is **damaged** and partial or total blindness results

# Cataracts

- Lens becomes **cloudy**
- Vision becomes blurry
- Caused by **denaturation** (“cooking”) of lens protein (UV light, diabetes, old age)
- Treatment: Remove the lens and replace it with a new one





# Macular Degeneration

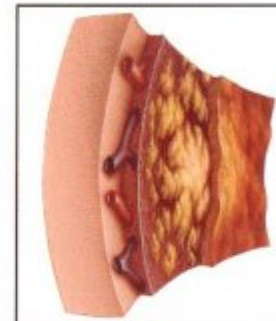


- Breakdown of the **retina** near the **macula** (fovea centralis)
- Main cause of blindness for people over 65
- Pressure on back of eye due to fat (“dry”) or blood leakage (“wet”)

Effect of Macular Degeneration



Normal macula



Degeneration of macula



Normal visual field



Abnormal visual field

