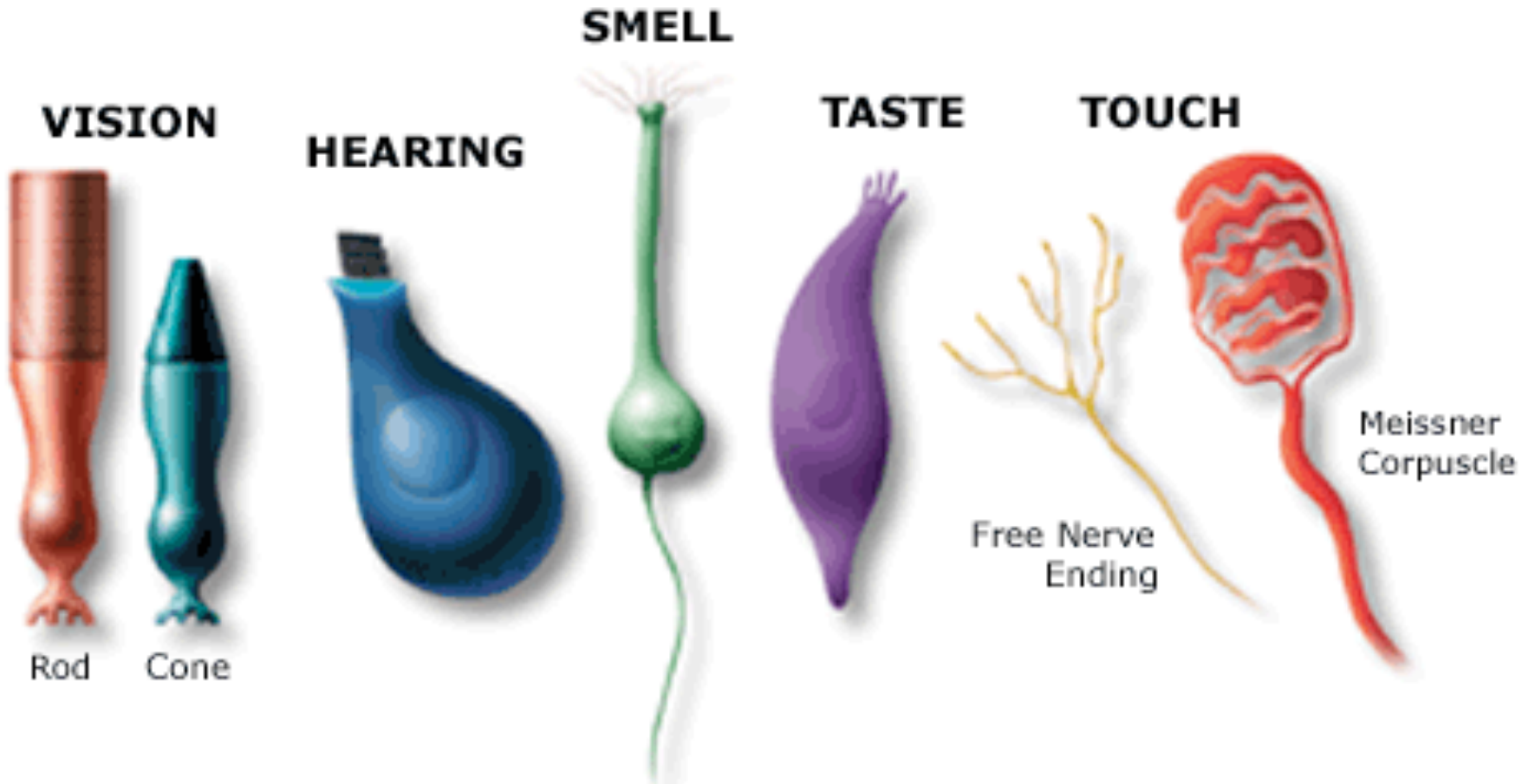
BOOKLET #4

SENSORY RECEPTION



SENSORY RECEPTION

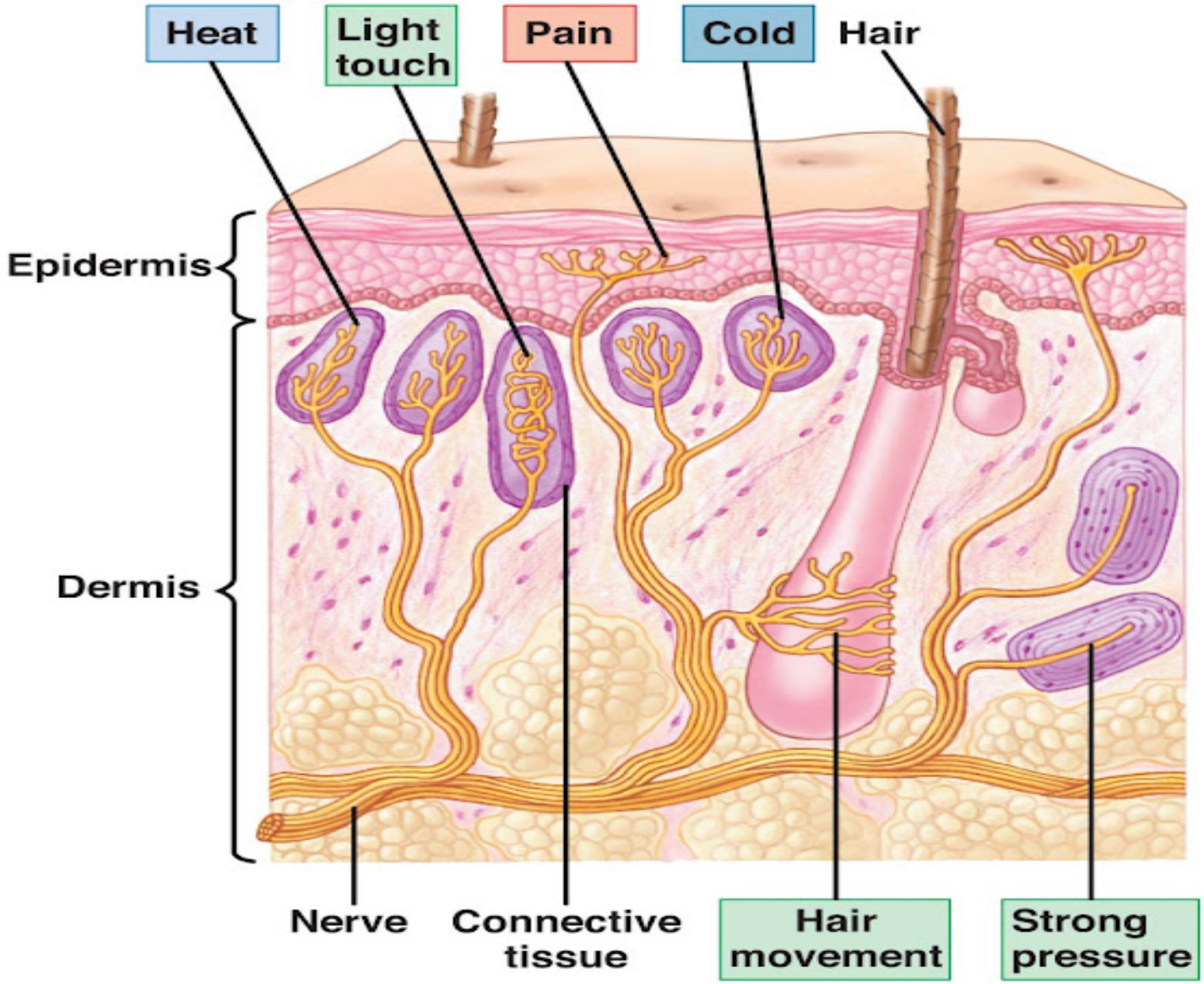
- As mentioned in the first part of this unit, sensory receptors detect specific stimuli and translate/ convert them into messages for sensory neurons to relay to the CNS.
- Our CNS then interprets these signals
- The four main groups of sensory receptors are

  - **Photoreceptors**- sensitive to light
  - **Chemoreceptors** – sensitive to certain chemicals
  - **Mechanoreceptors**-sensitive to pressure and/or movement
  - **Thermoreceptors** – sensitive to temperature

The Bodies SENSORY RECEPTORS

Receptor Type	Stimulus	Information Provided
TASTE	Chemical	Presence of certain chemicals (identified by taste buds)
SMELL	Chemical	Presence of certain chemicals (identified by olfactory cells)
PRESSURE	Mechanical	Movement of skin or changes in body surface
PROPRIOCEPTOR	Mechanical	Body movement and positioning
BALANCE	Mechanical	Body movement detected by inner ear
AUDIO	Sound	Sound waves in air changed into mechanical vibrations
VISUAL	light	Changes in light intensity, movement, colour
THERMORECEPTOR	temperature	Flow of heat

SENSORY RECEPTORS IN THE SKIN



Do you know you're wearing clothes?

- **Sensory adaptation** occurs once the **receptor** **becomes accustomed to the stimulus**

- Neurons stop firing even if the stimulus is still present
  - Ex. Jumping in a cold lake and bad smells

Bozeman: Sensory System 10:31

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

How do we know where our hands are in space?

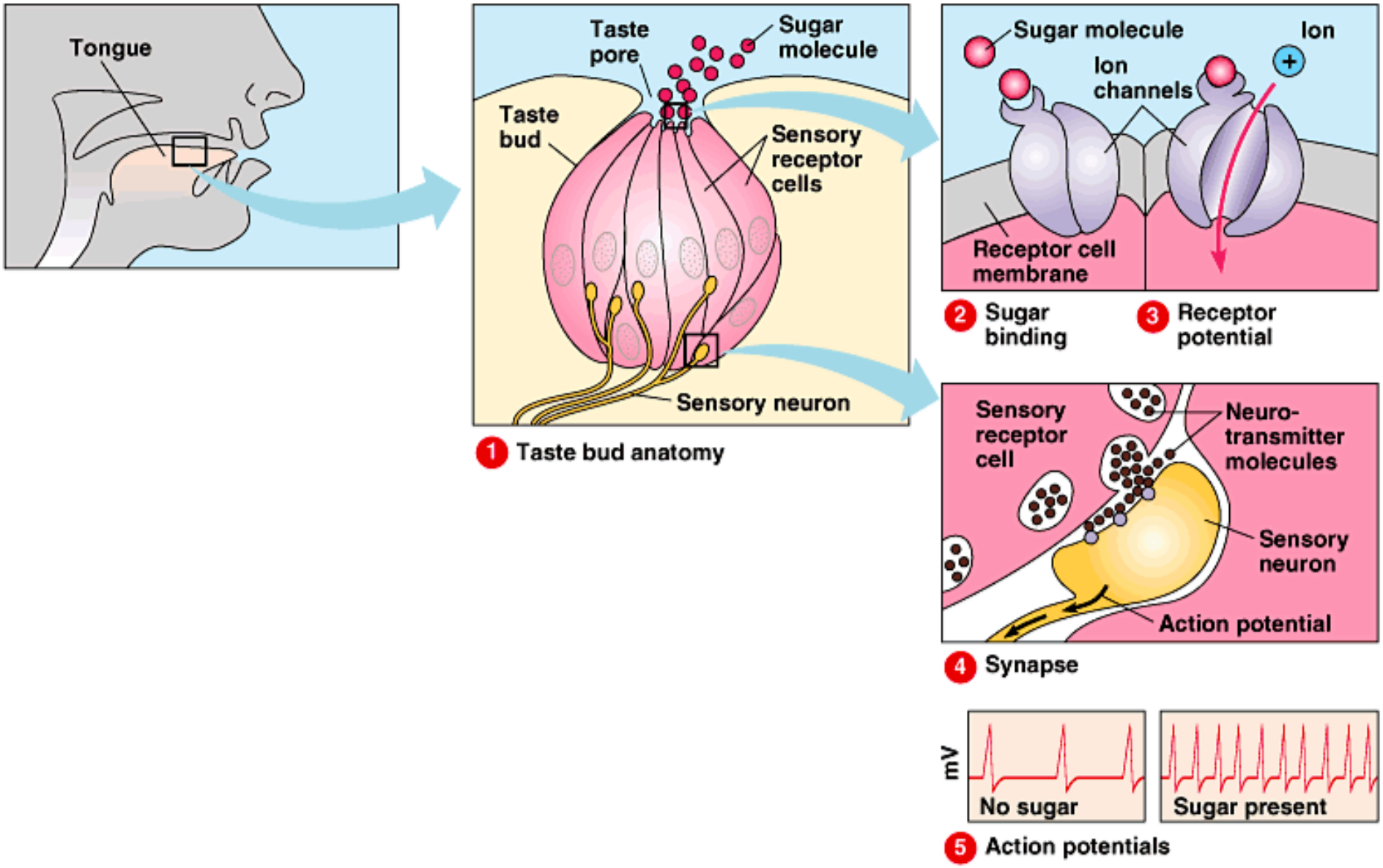
Limb Position:

- **Proprioceptors** are **stretch receptors** in muscles, tendons and joints throughout the body.
- They send information about body position to the brain.
- Regular exercise makes these receptors very "smart"

Tasty!

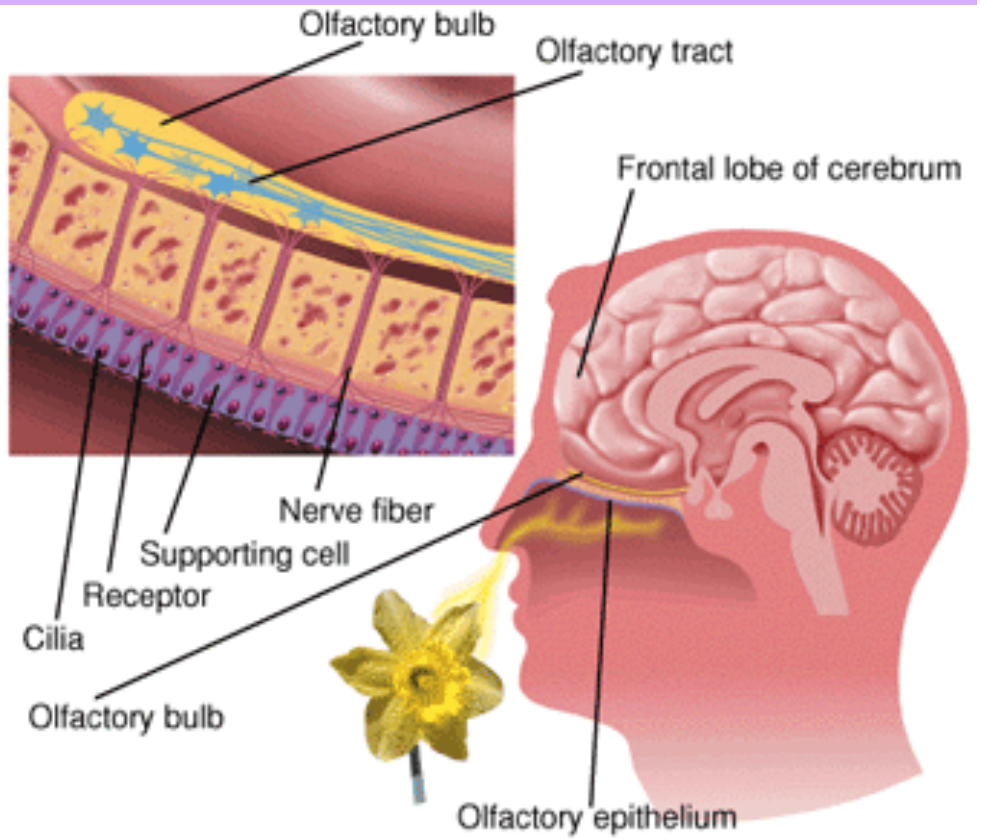
- Taste receptors (found inside taste buds) pick up the chemicals in dissolved food
- **Chemoreceptors** then send AP's down the neuron
- Each taste bud can actually detect various tastes because they contain many chemoreceptors

YUMMMM Tasty!

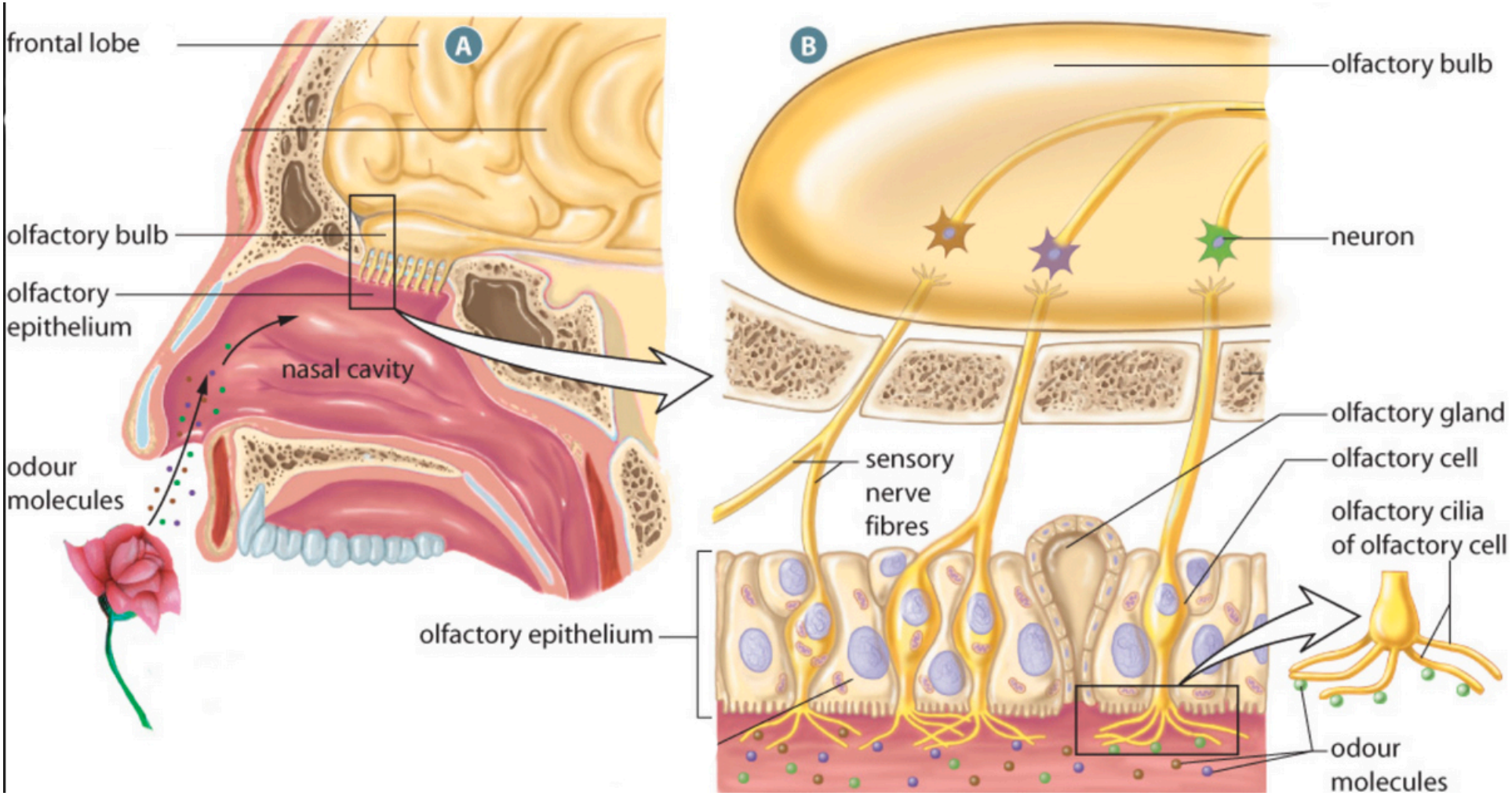


Olfactory: Smell

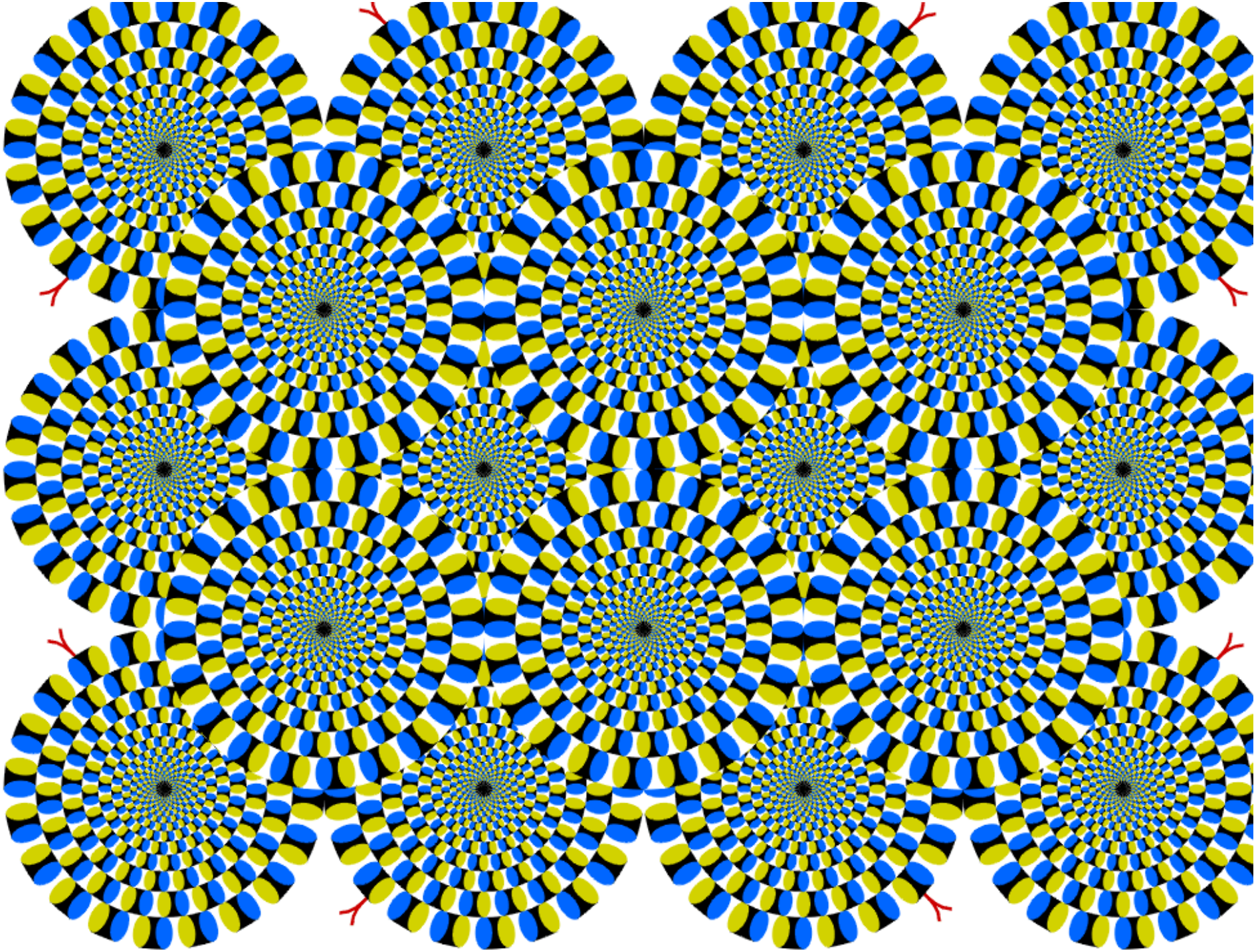
- **Humans can distinguish**
  10 000 different smells
- **Chemicals attach to olfactory receptors in the nose and nerve impulses are sent to the temporal lobe**
- these are 3000x more sensitive than taste receptors

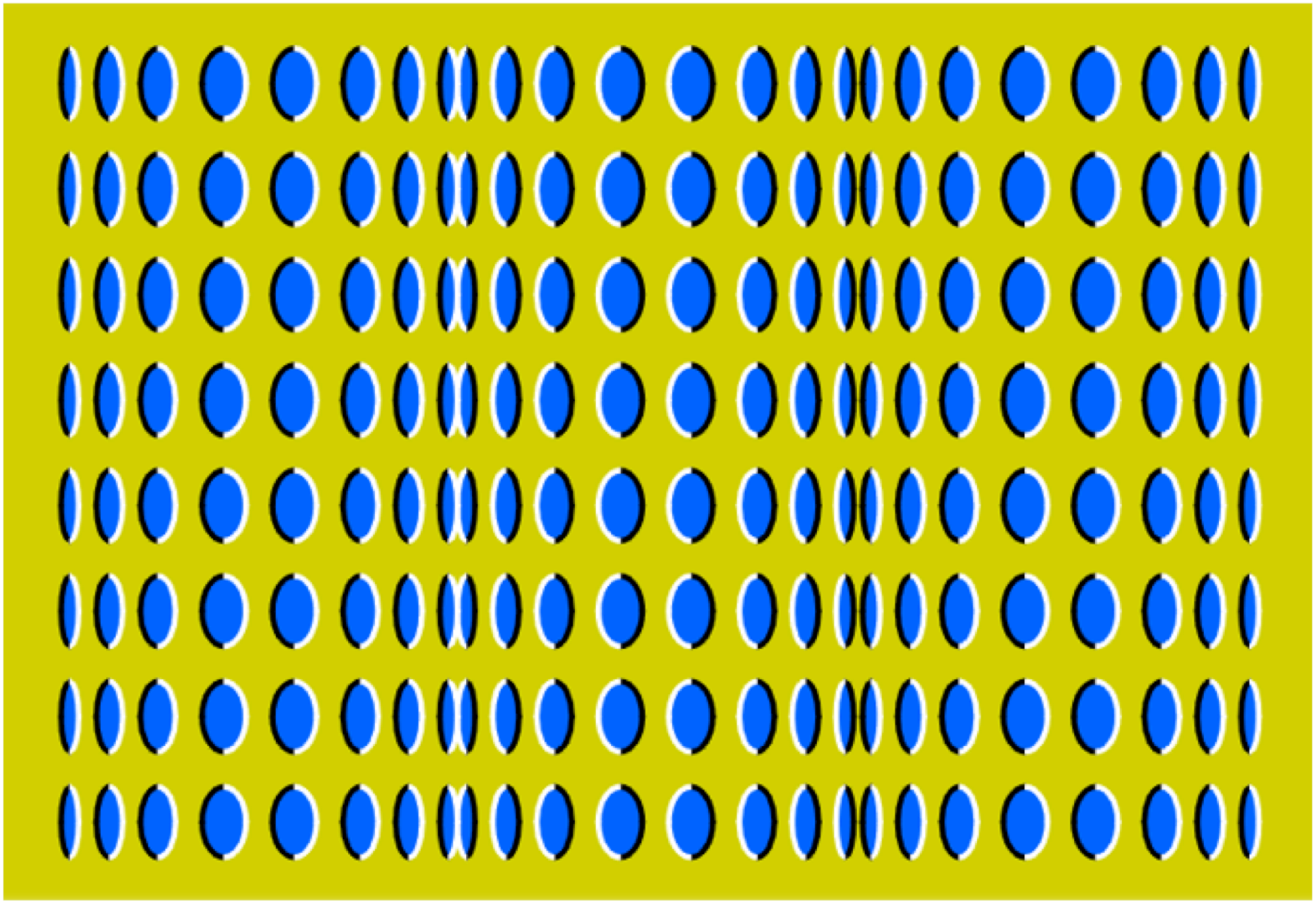


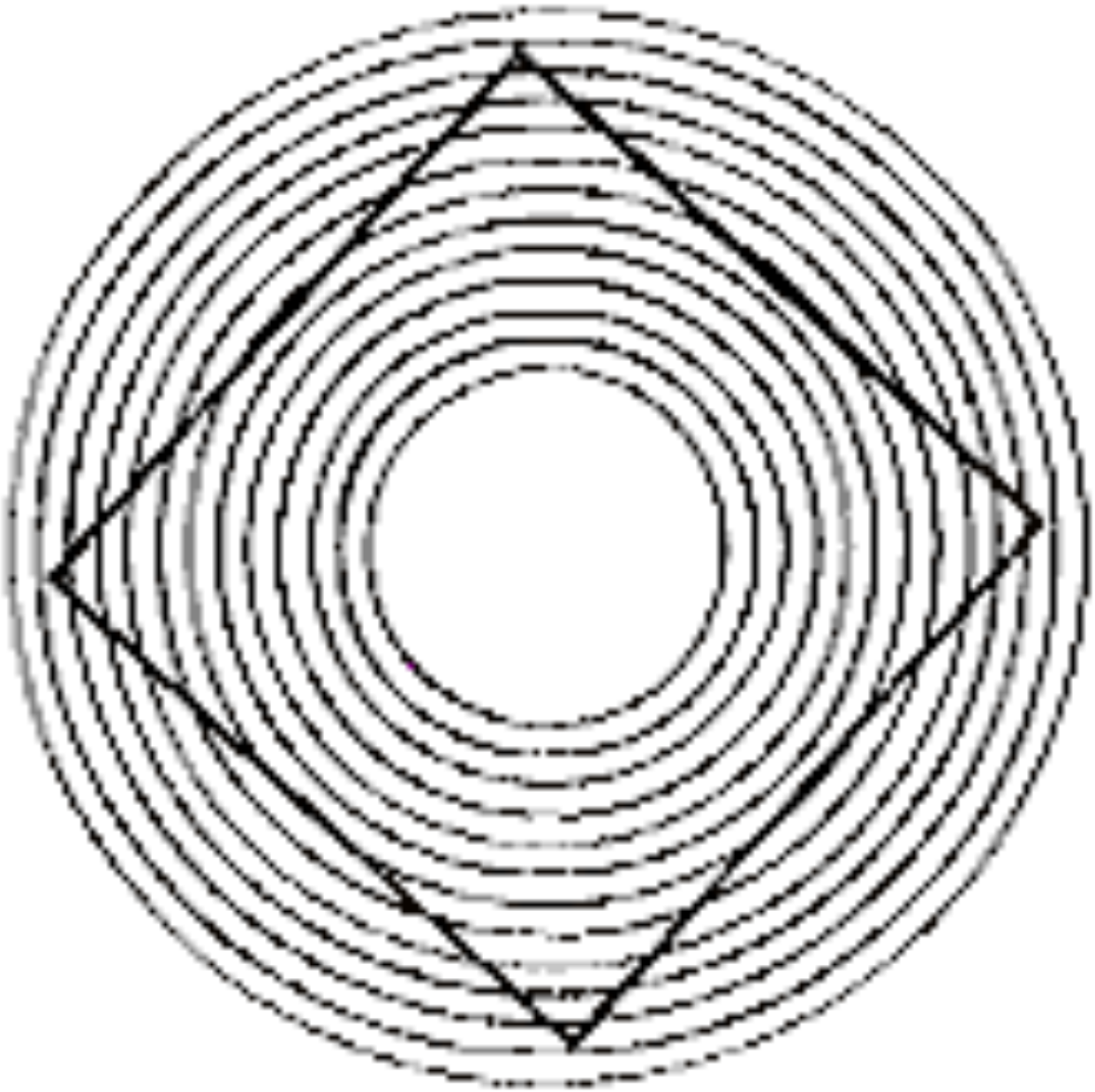
Olfactory: How do we Smell?

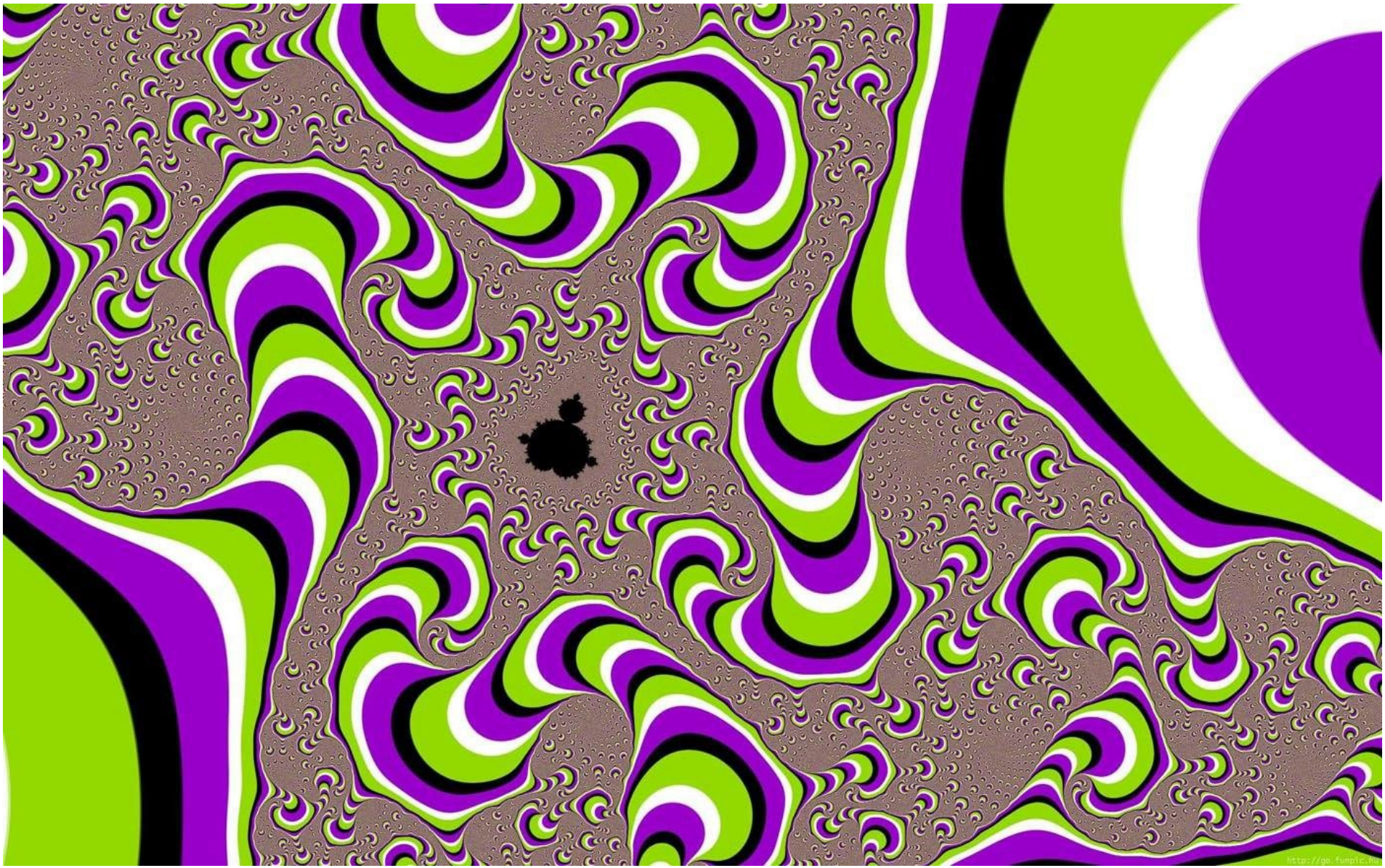


"It's only Wednesday but something in the air makes me obsess about the weekend!"









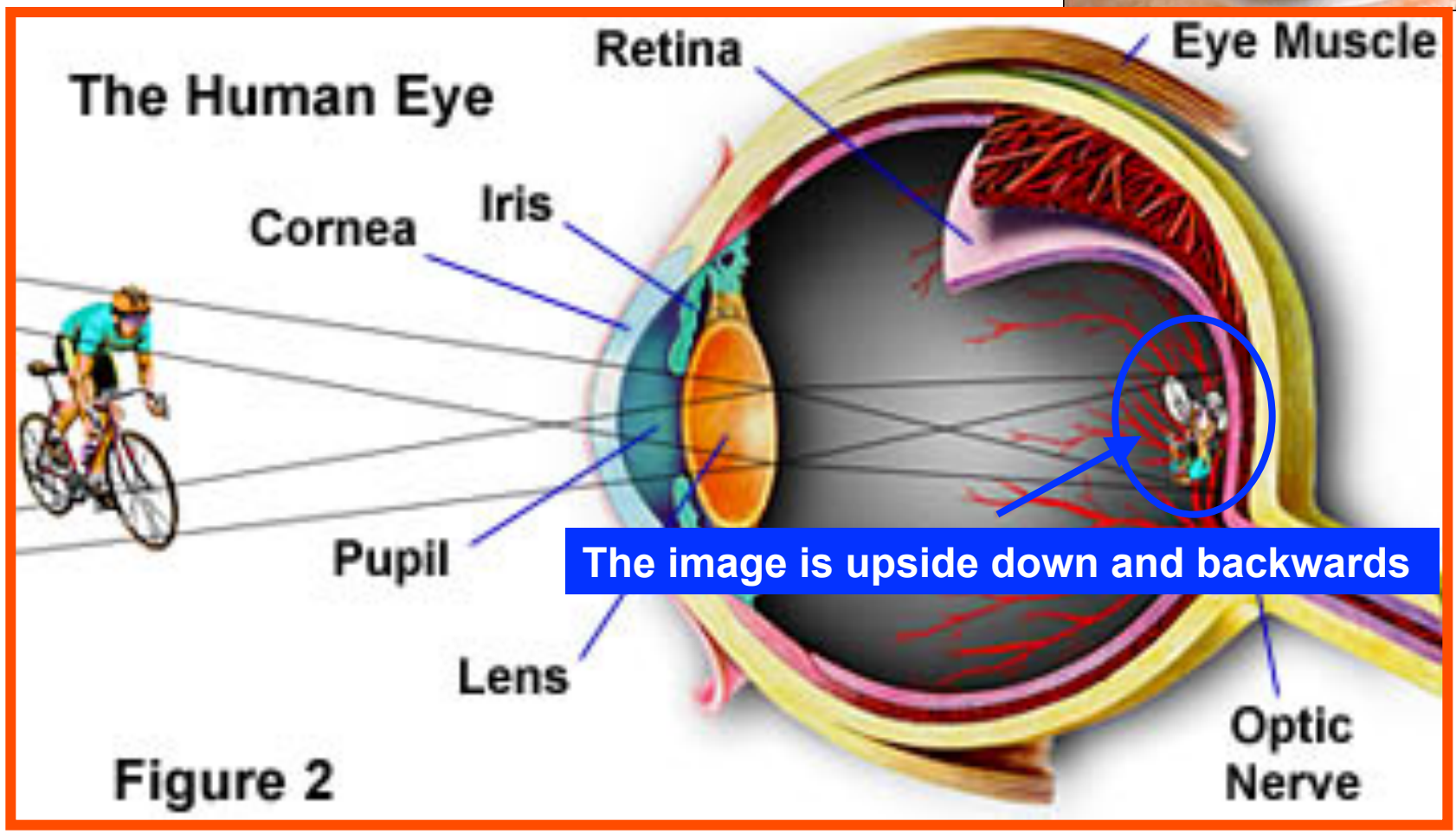
Charlie Chaplin Hollow Mask Illusion

http://www.youtube.com/watch?v=QbKw0_v2clo&safety_mode=true

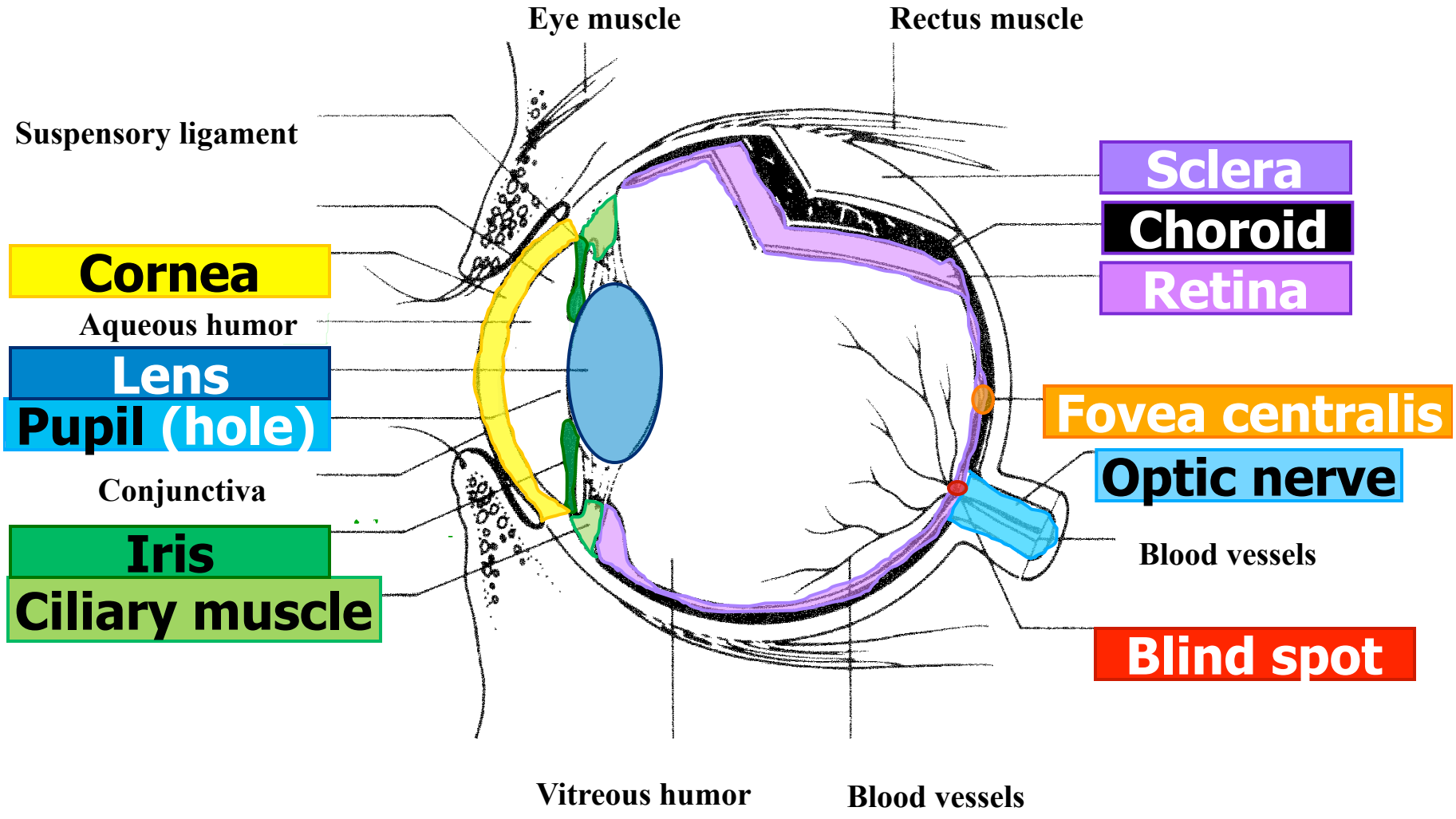
More Illusions:

http://youramazingbrain.org/

The Human Eye



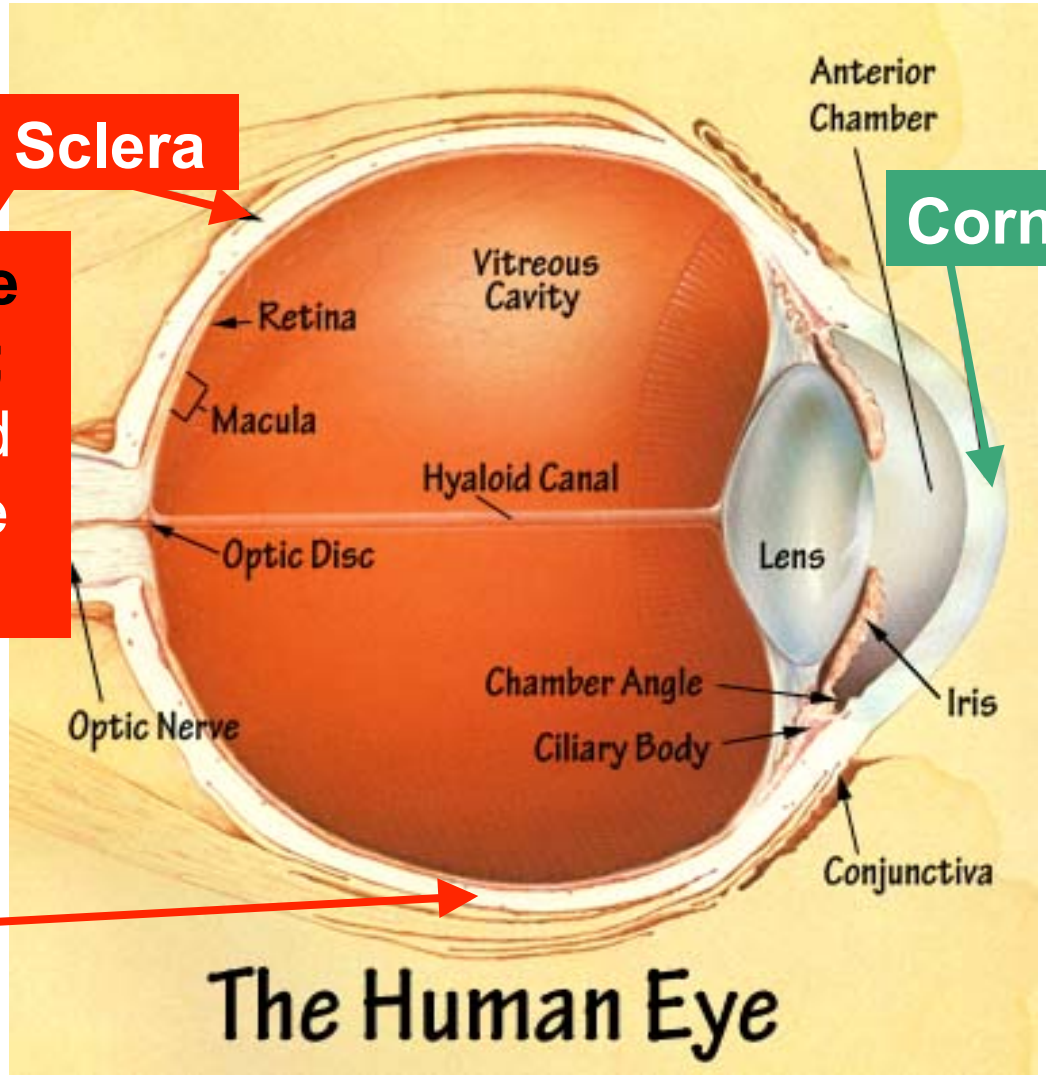
The Eye



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

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

Sclera and Cornea (outer layer)



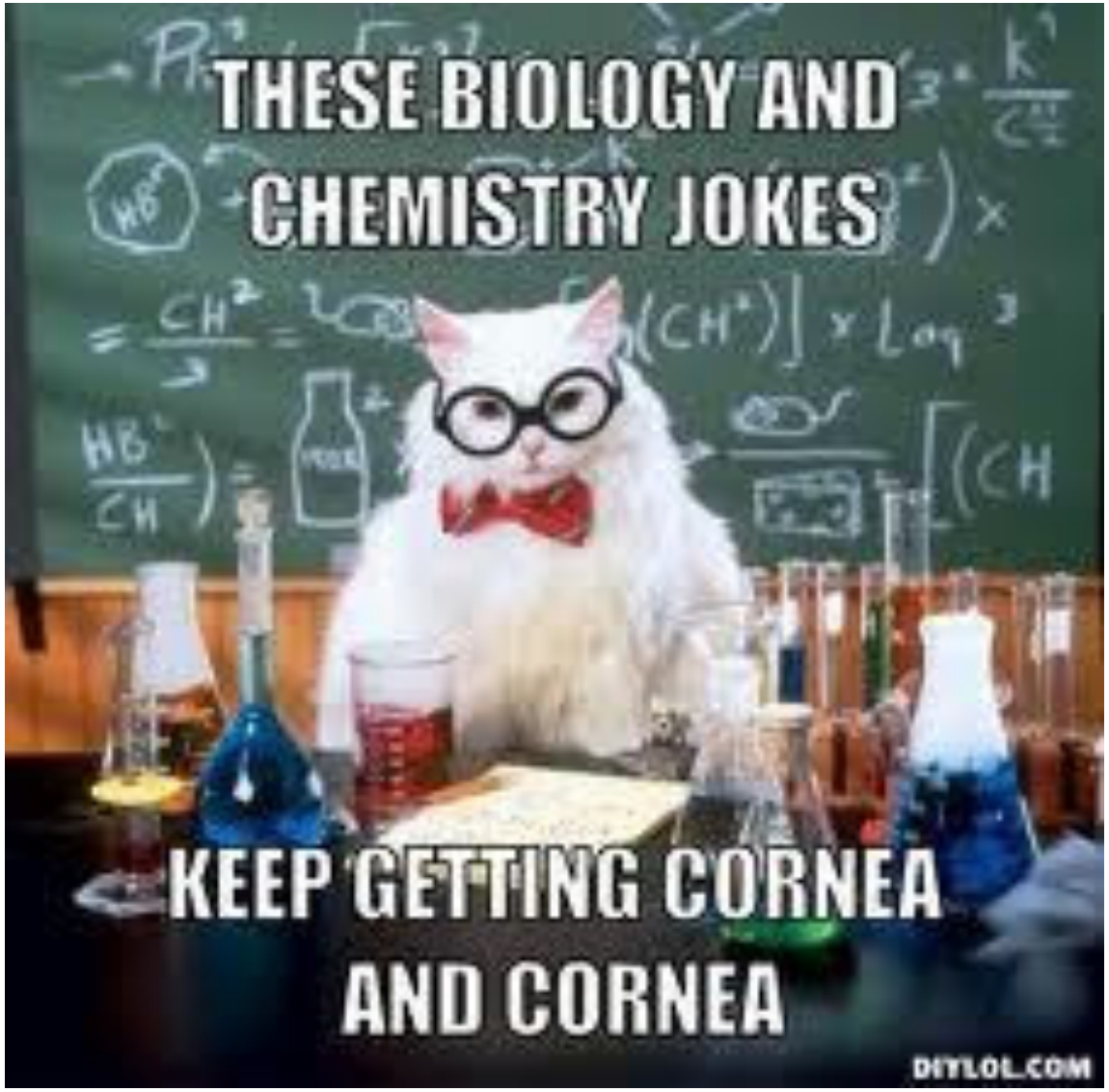
Tough, **white outer layer;** Protects and supports the eye

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

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
DIYLOL.COM

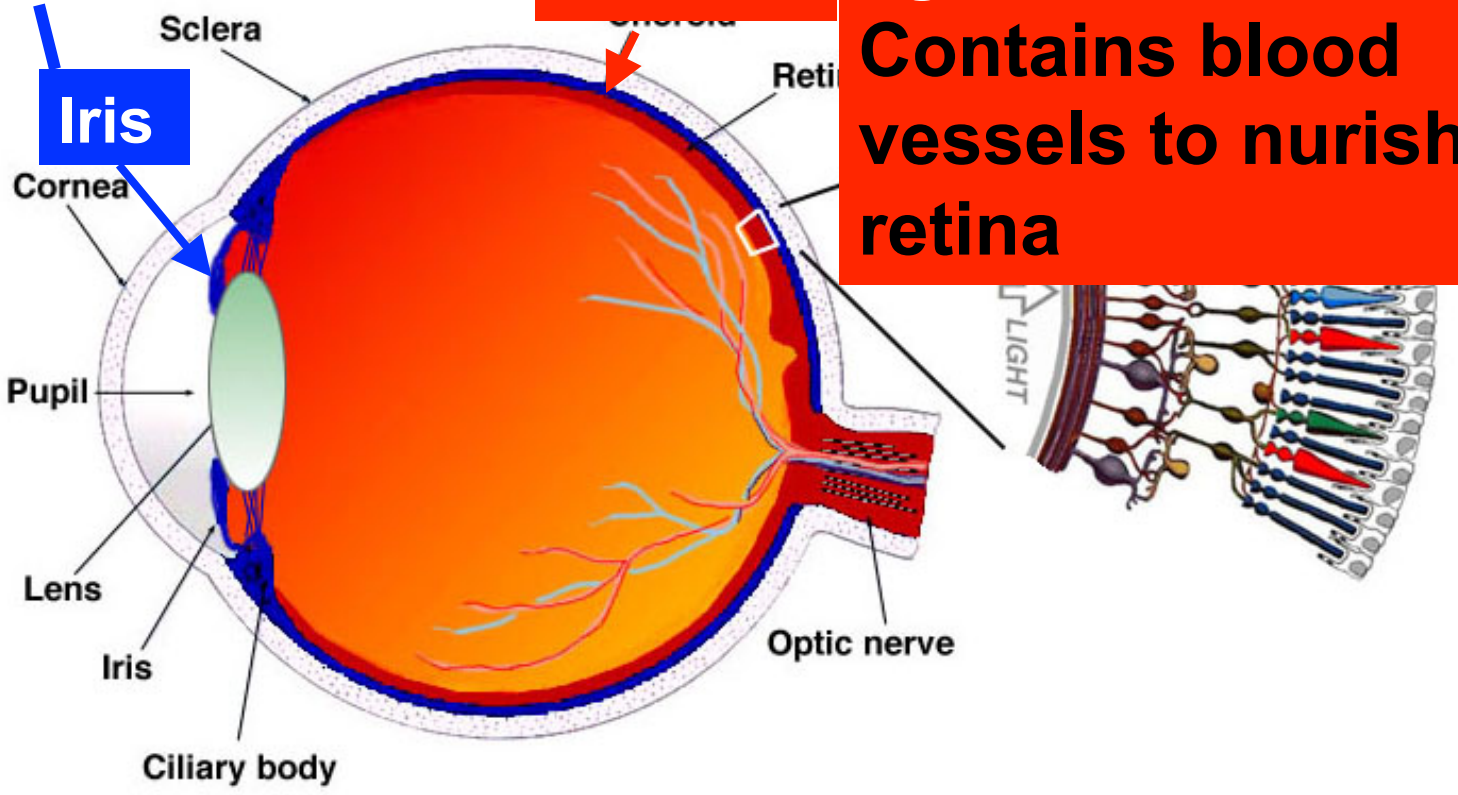
Choroid layer

(middle layer) and the Iris

Pigmented muscle, controls pupil size

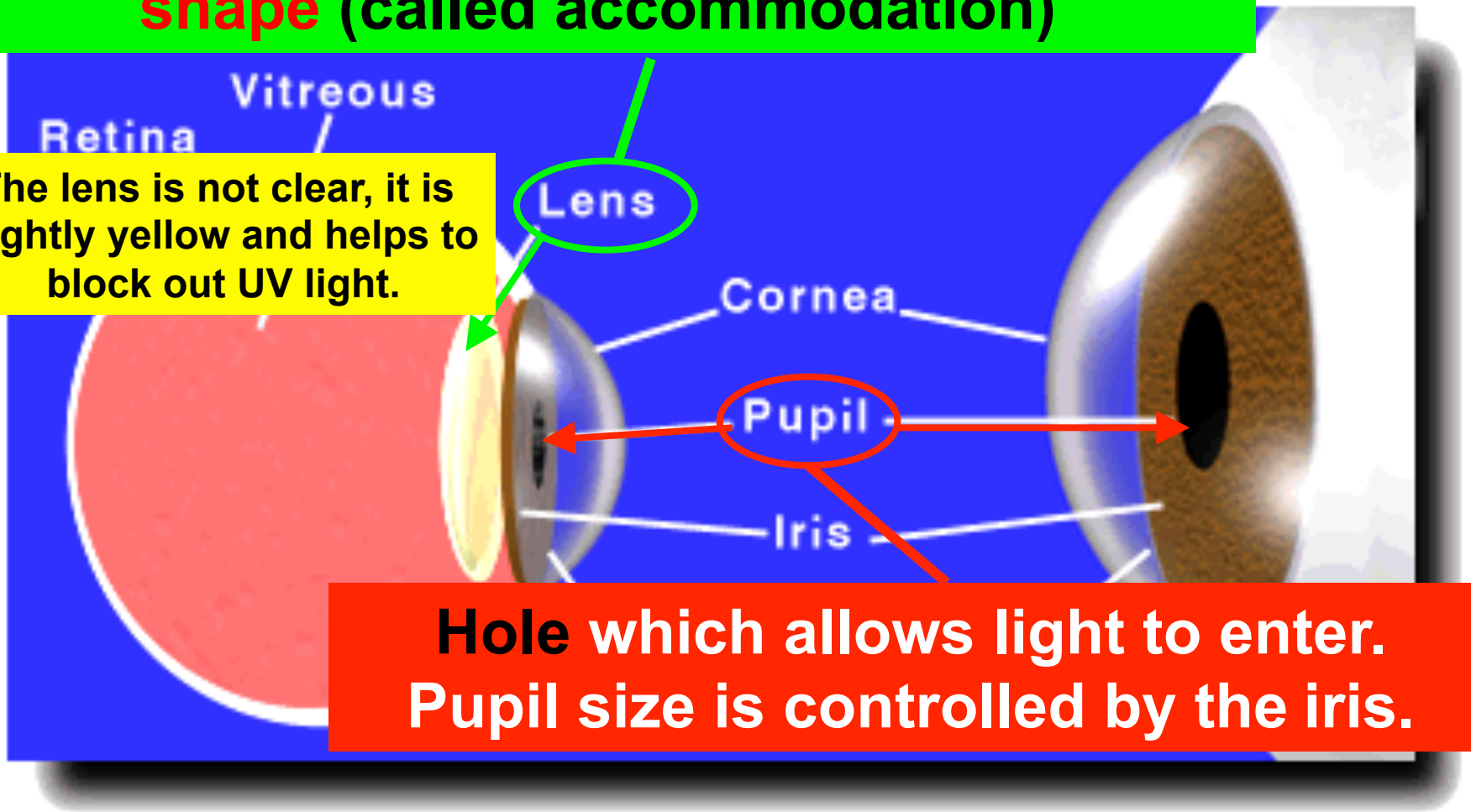
Choroid

Black layer, prevents light from scattering. Contains blood vessels to nurish retina



Pupil and lens

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

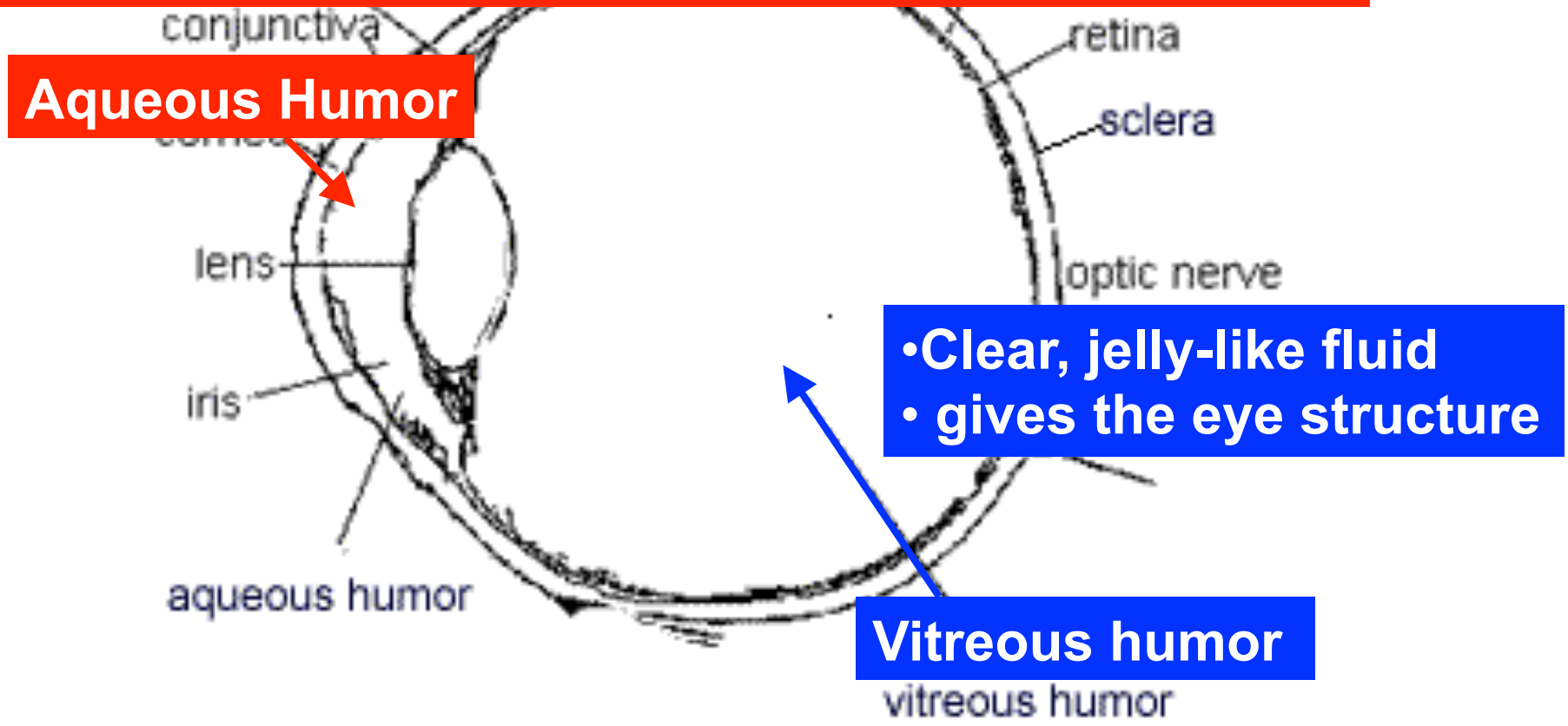


The lens is not clear, it is slightly yellow and helps to block out UV light.

Hole which allows light to enter.
Pupil size is controlled by the iris.

Aqueous Humor and Vitreous Body

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

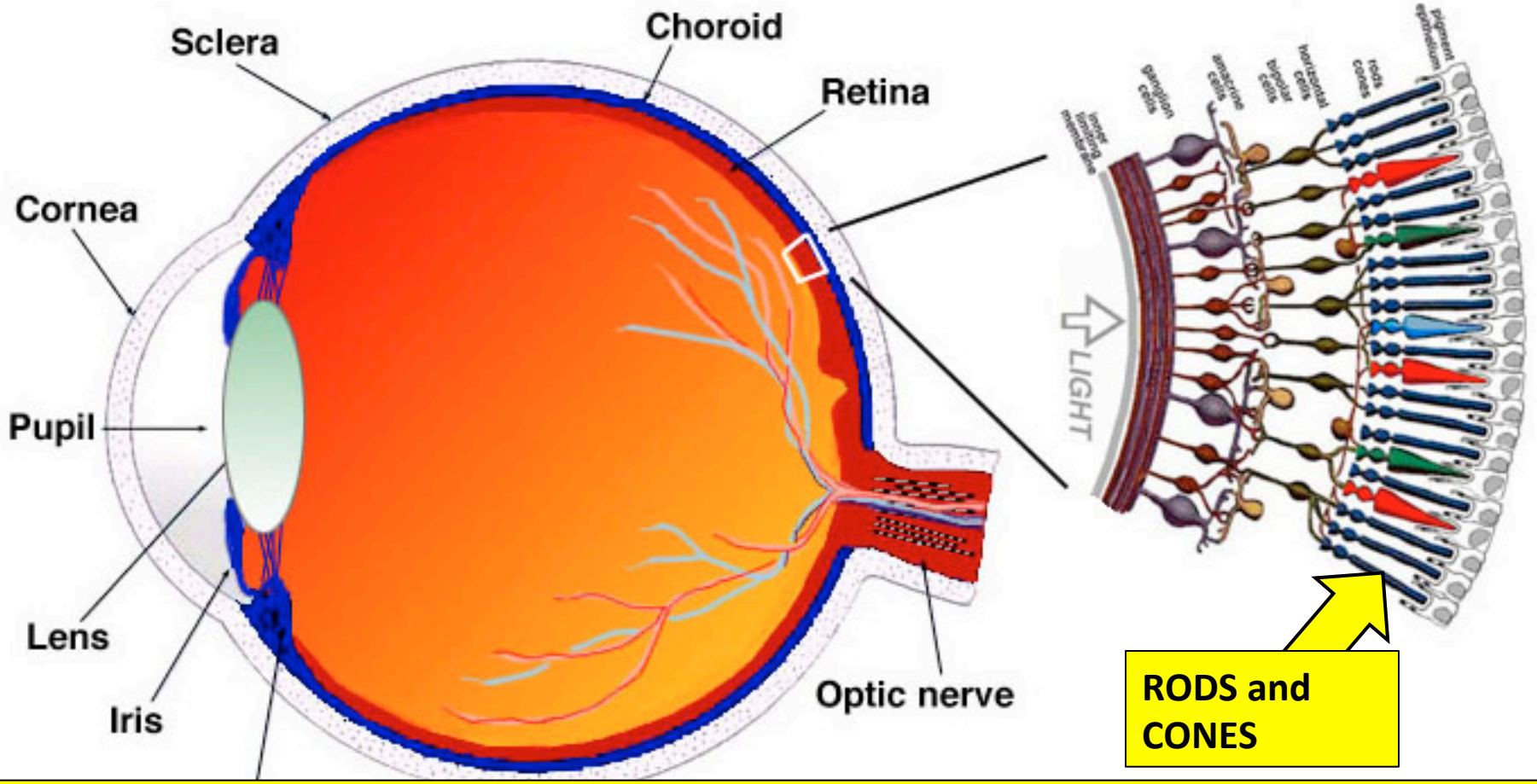


Aqueous Humor

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

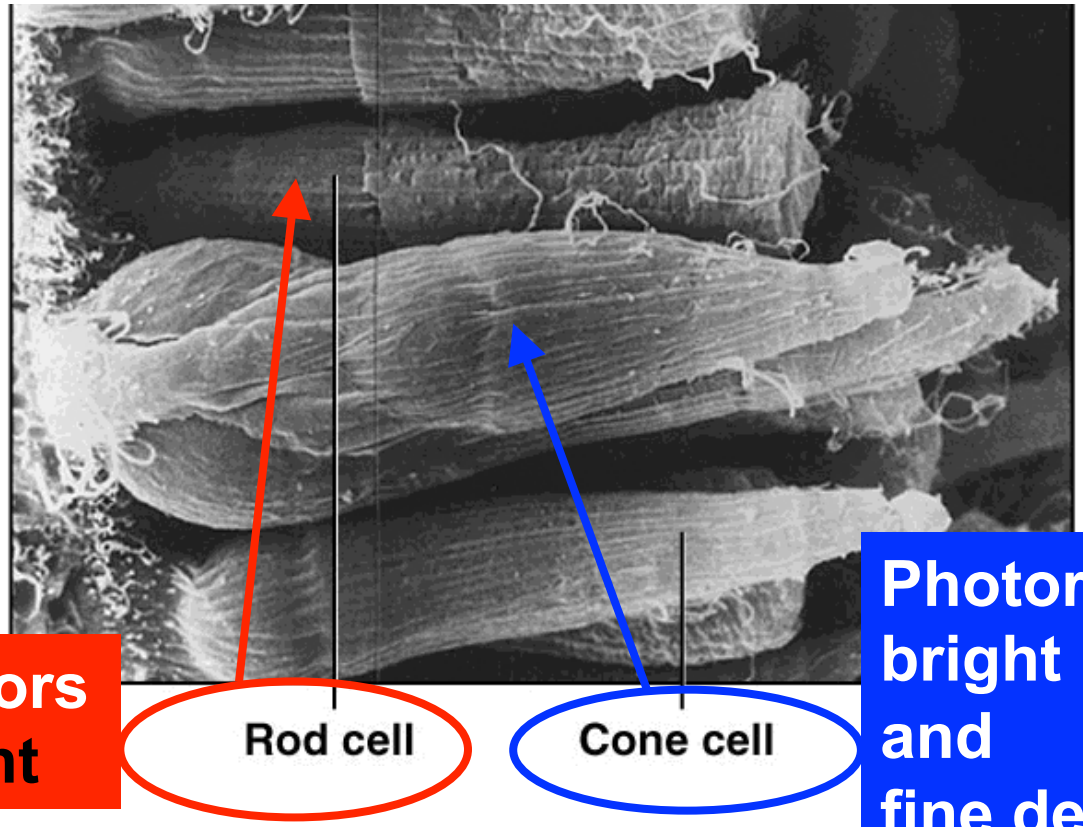
Vitreous humor

The Retina
(inner most layer)



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

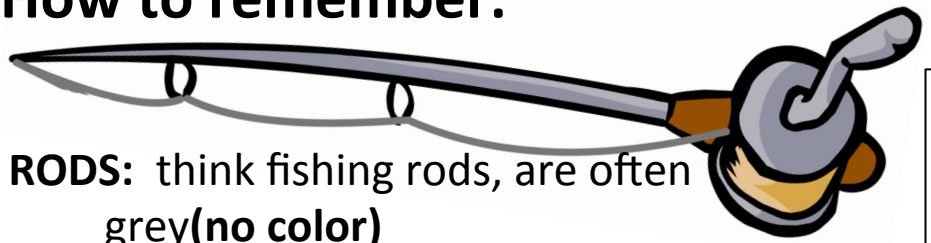
Rods and Cones



Photoreceptors for dim light

Photoreceptors for bright light, color and fine detail

How to remember:



RODS: think fishing rods, are often grey**(no color)**

CONES: think bright orange pylon cones… also… they both start with "C" "**C**olour)

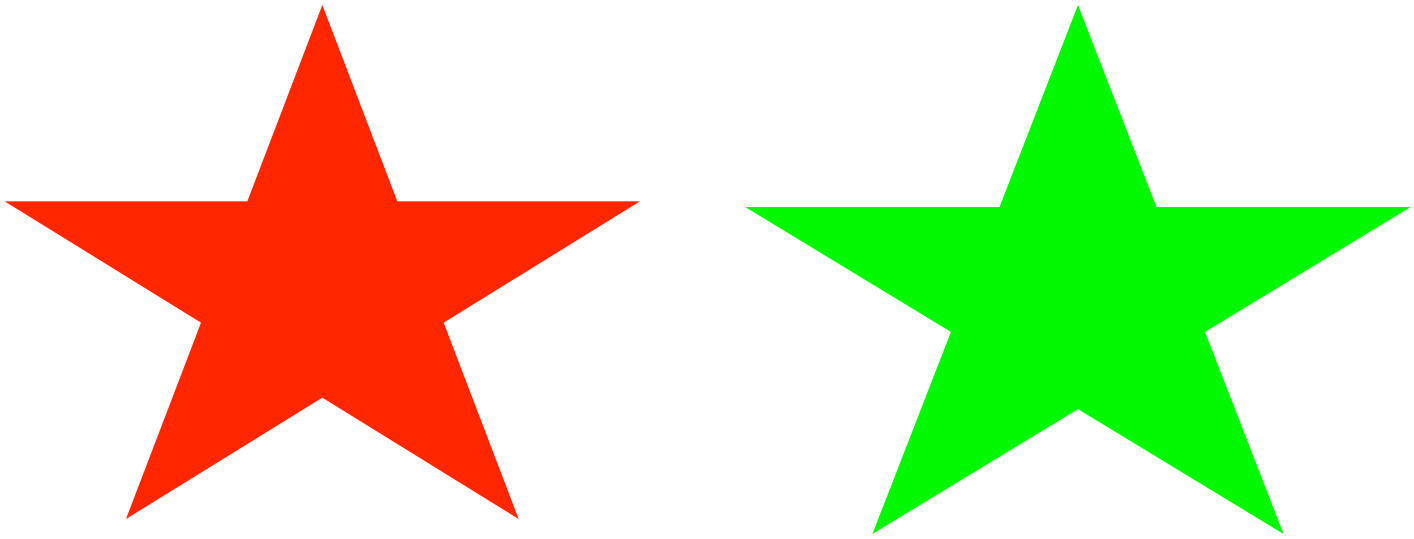
Do animals have rods and cones?

- Hawks have 600 million rods in the center of their retina
  - This means there eye sight 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!

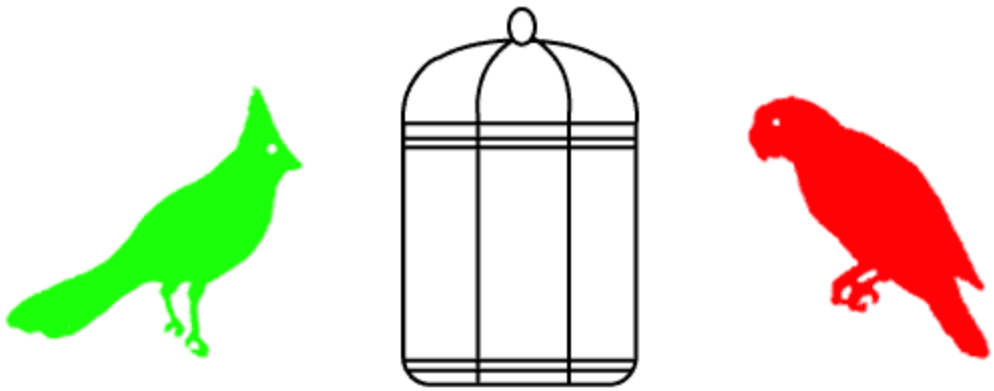


Now stare at the white background!

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,

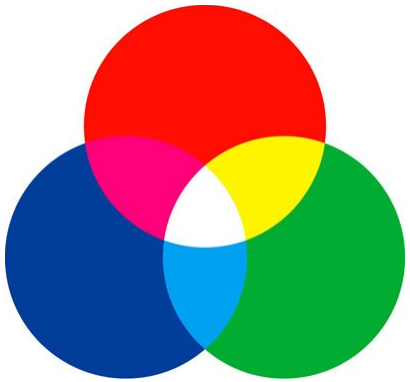
Now stare at the empty cage!



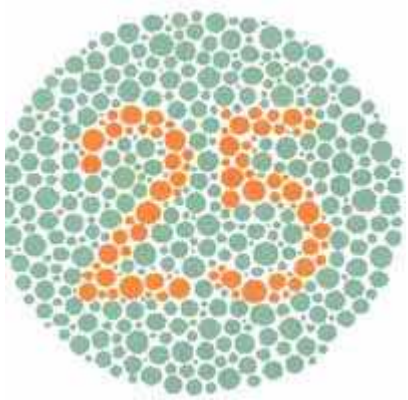
Did you take your vitamin A?

- **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

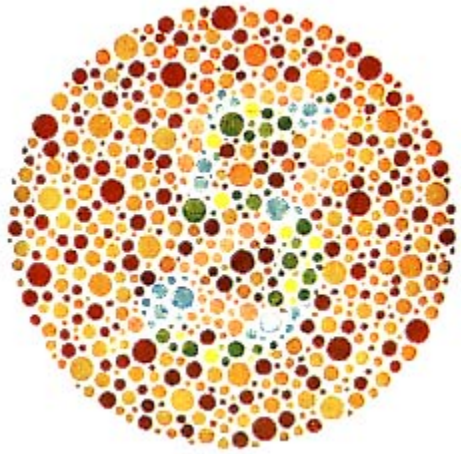
Color blindness



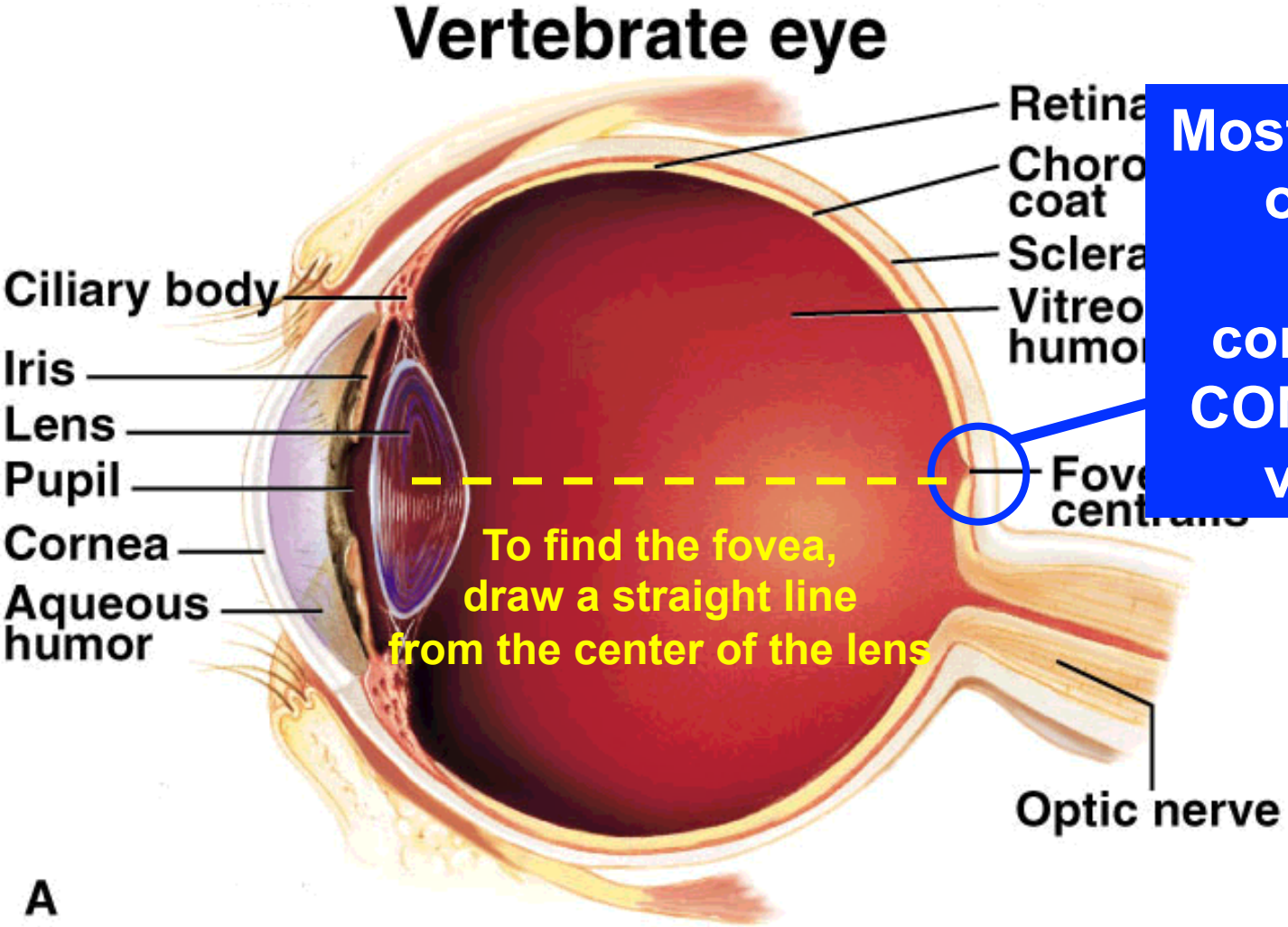
- Color blindness occurs when **one or more cones** are defective
- **Red-green** color blindness is most common
- Caused by a genetic defect on the X chromosome



What numbers do you see?



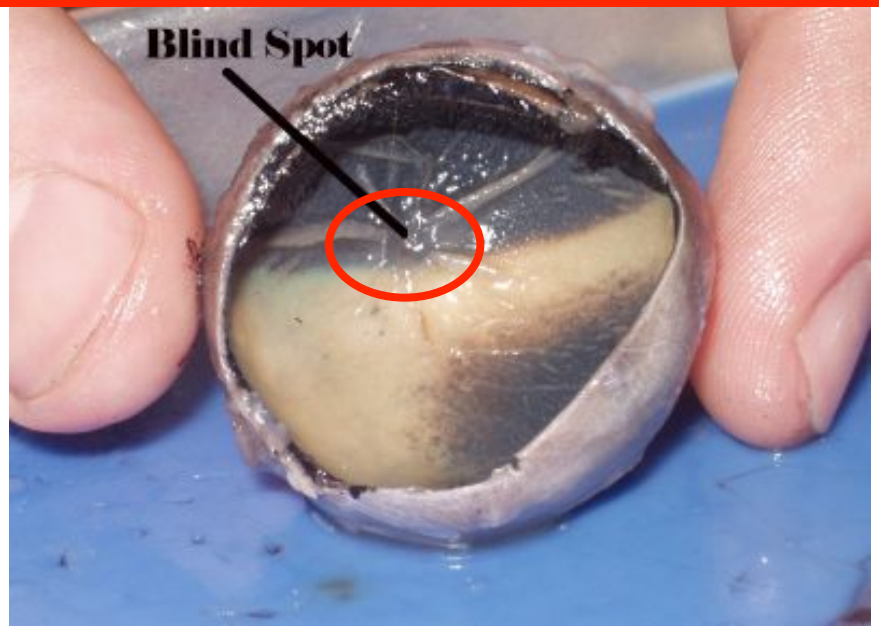
Fovea centralis (macula)

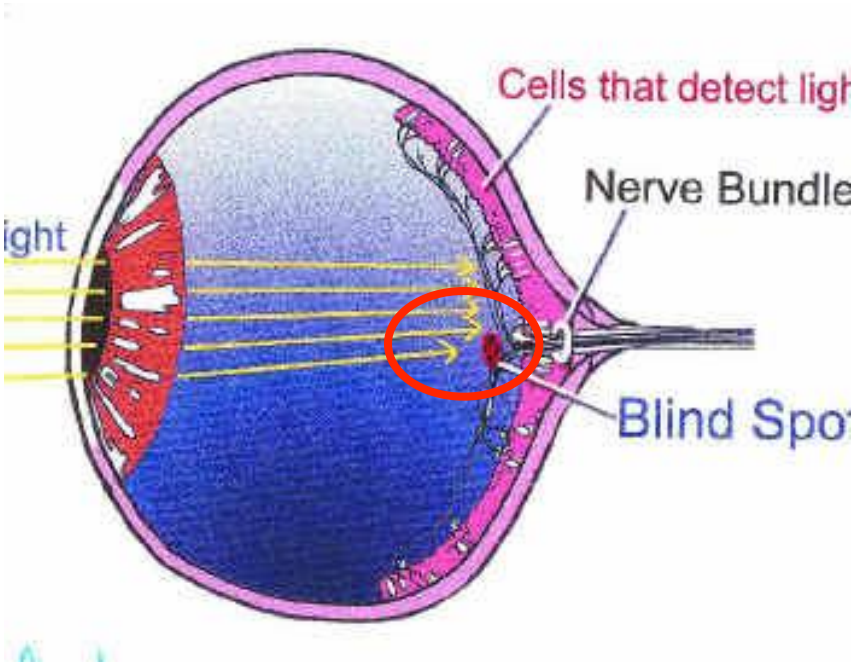


Most sensitive area of the retina, highest concentration of CONES = greatest visual acuity

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

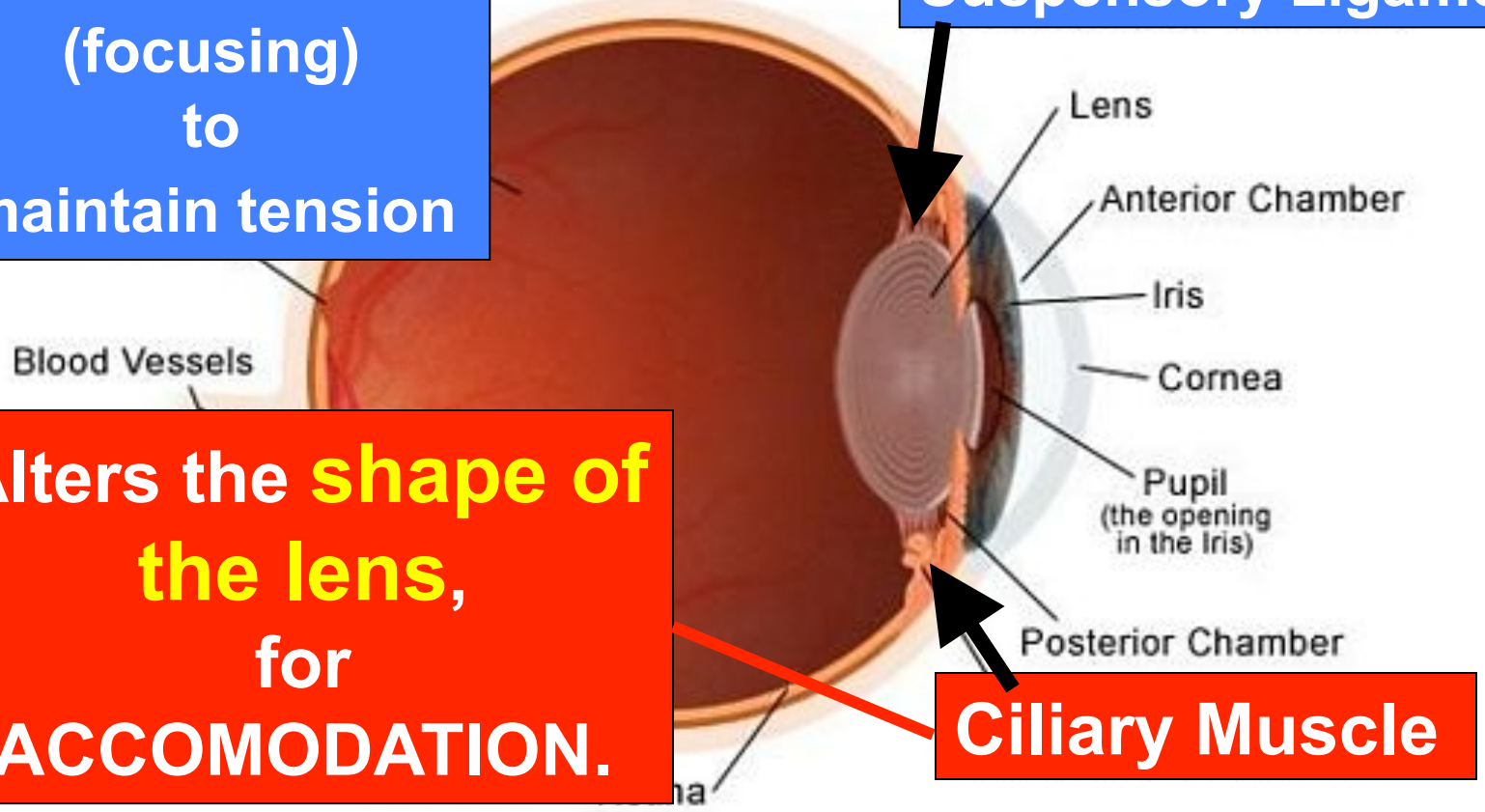
Find Your Blind Spot

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

Ciliary Muscle and Suspensory Ligaments

Important in accommodation (focusing) to maintain tension

Suspensory Ligaments



Alters the shape of the lens, for ACCOMODATION.

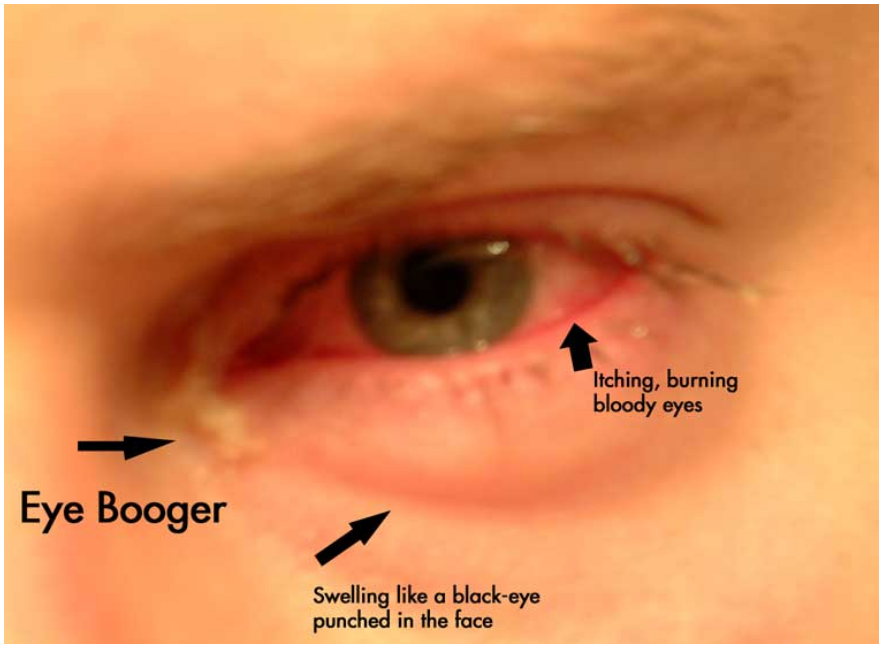
Ciliary Muscle

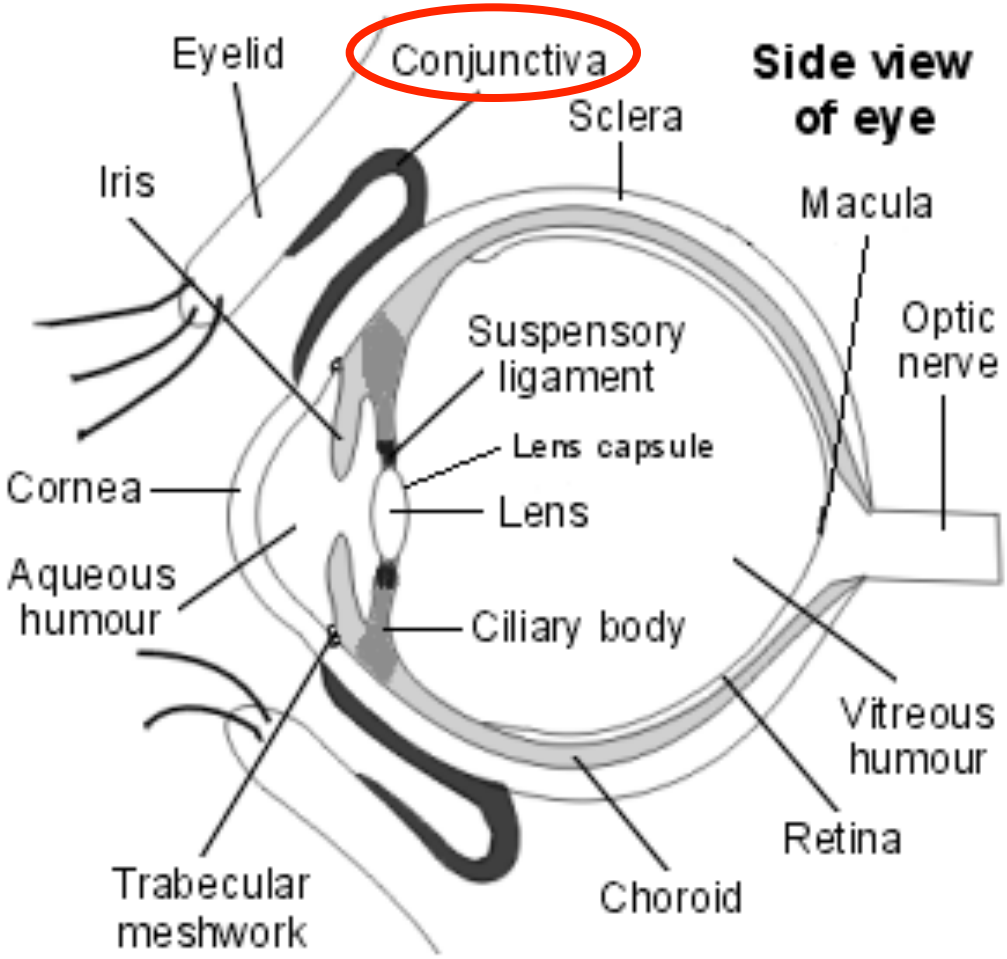
Conjunctiva

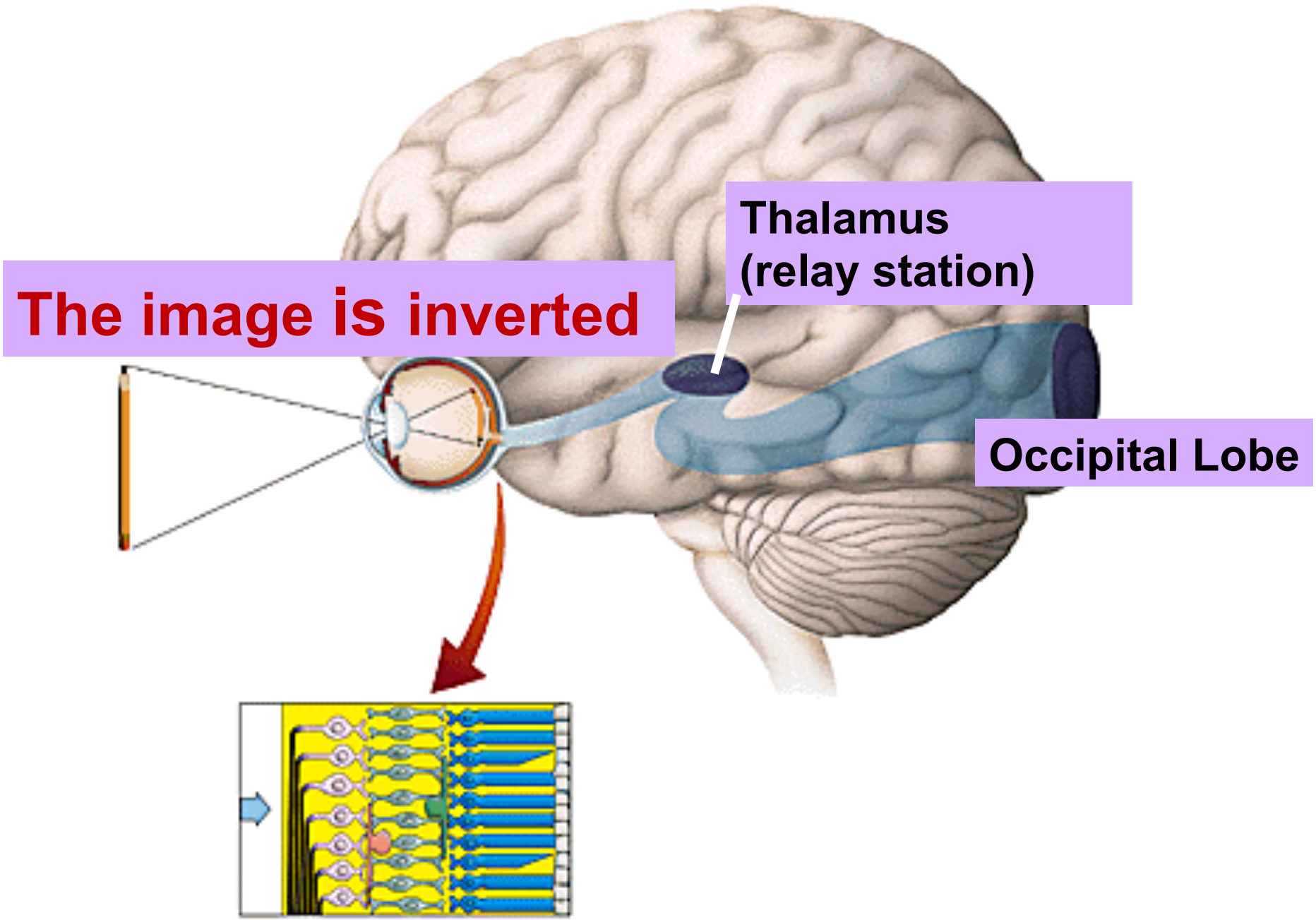
Pink eye = infection of the conjunctiva

Thin layer on top of the cornea for protecting the eye

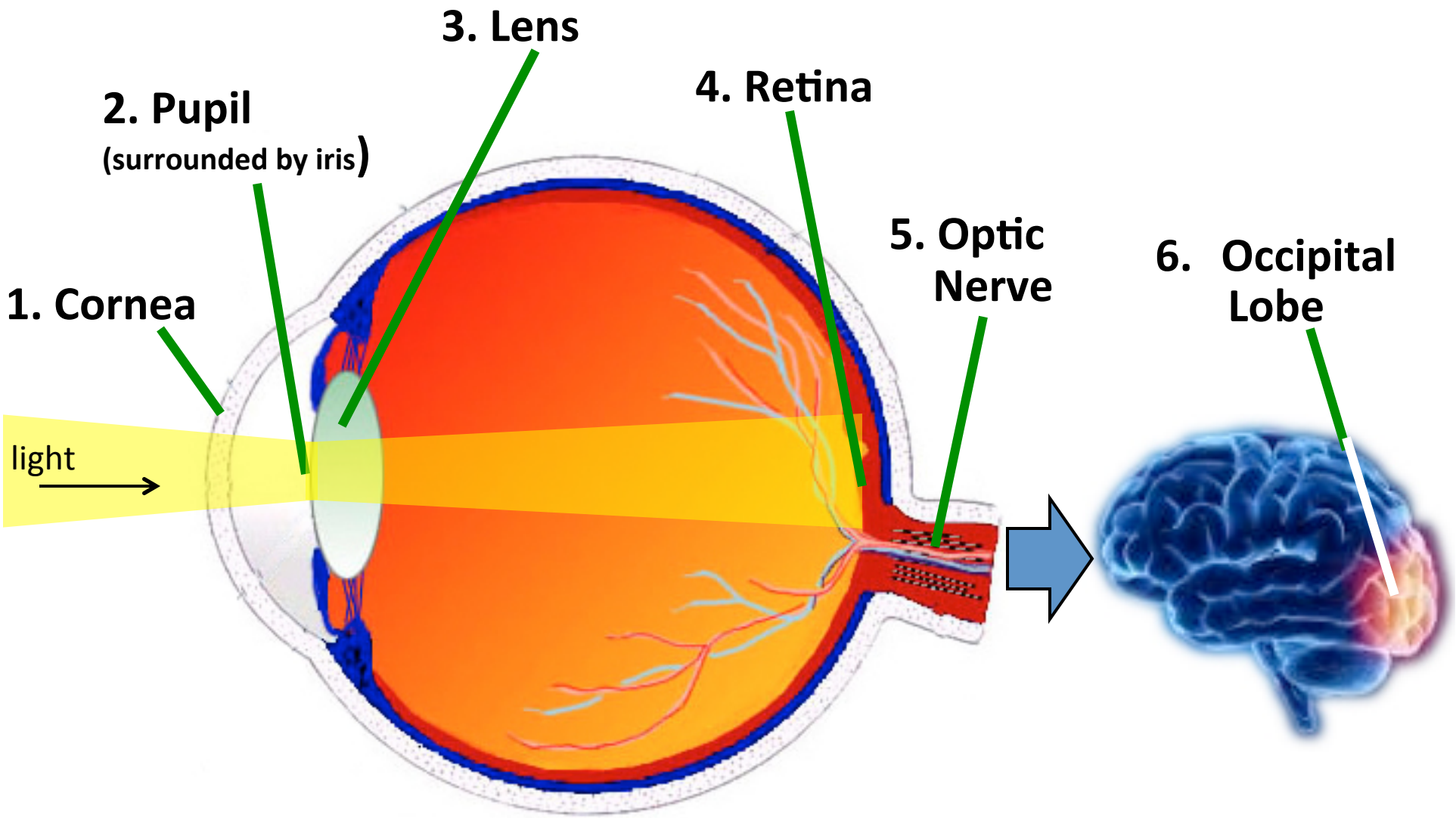
Blocks entry of pathogens into the eye





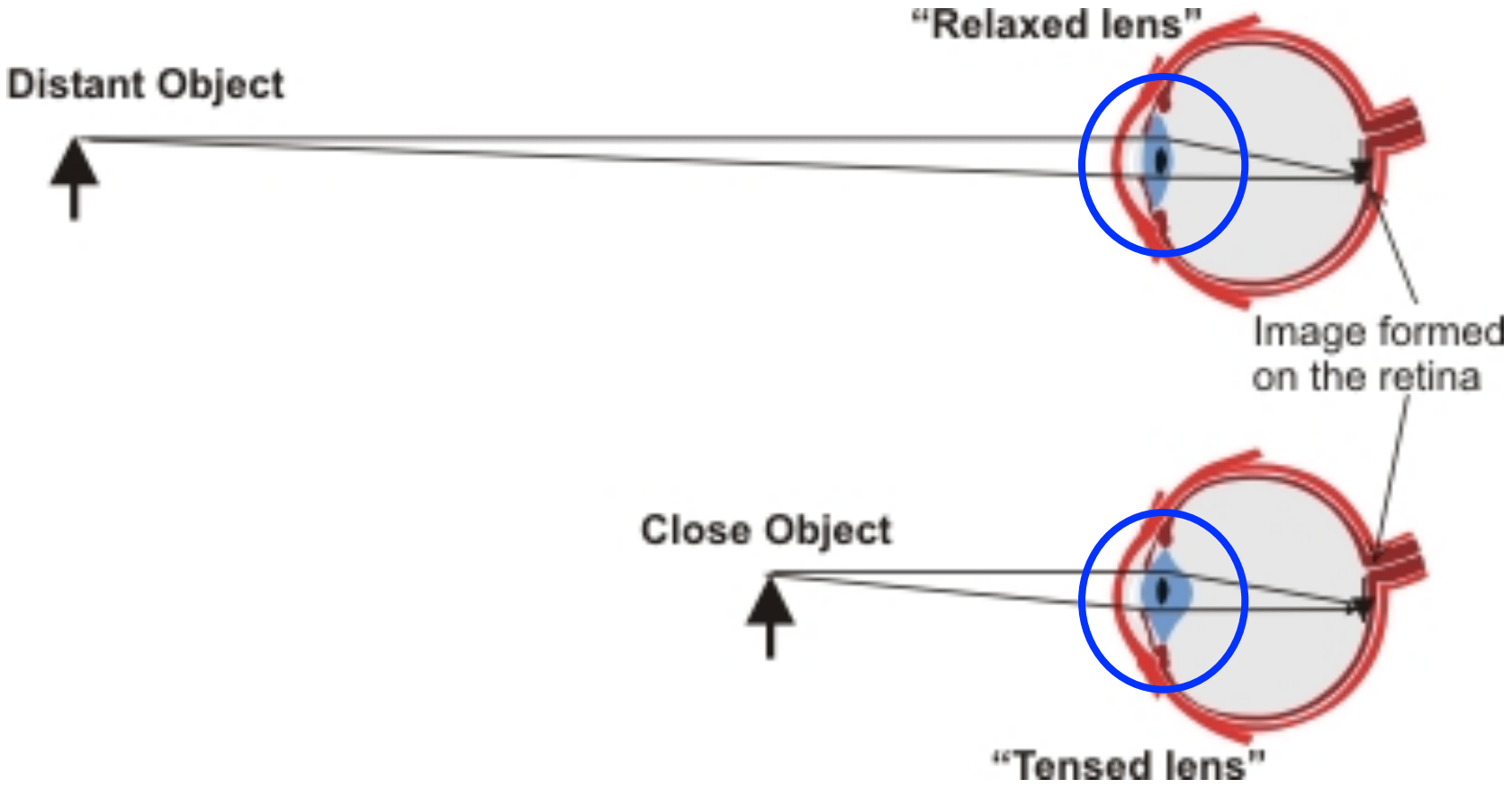

The image is inverted
Thalamus
(relay station)
Occipital Lobe

Pathway of Light into Eye (and brain)



Accommodation

Lens changes shape to focus.

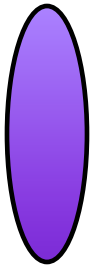


accommodation

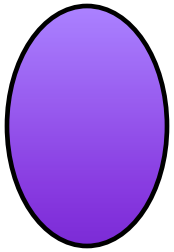
****Lens changes shape to focus****

Accommodation is controlled by **ciliary muscles**.

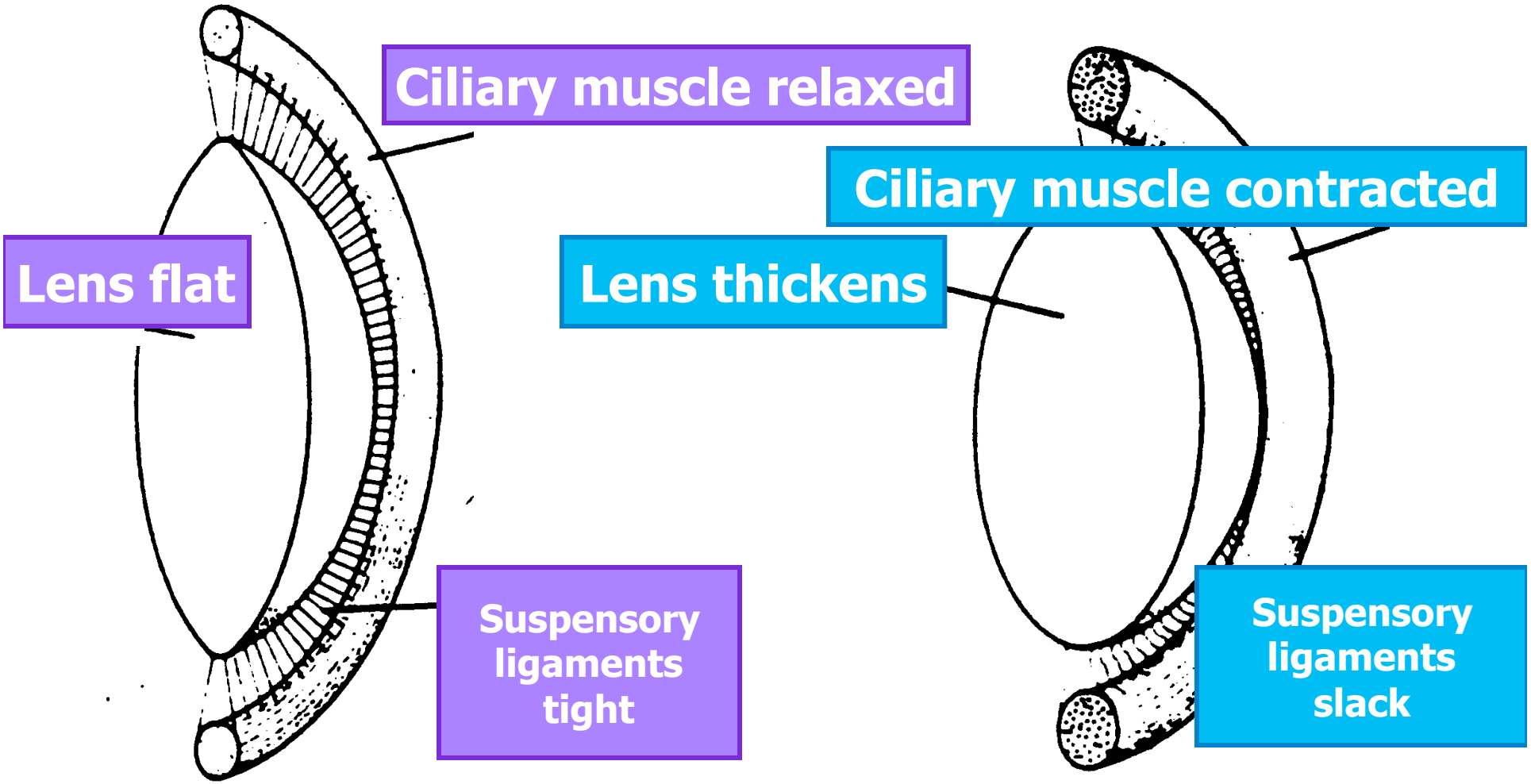
Flat lens: used to view far away objects



Thicker lens: used to view closer objects



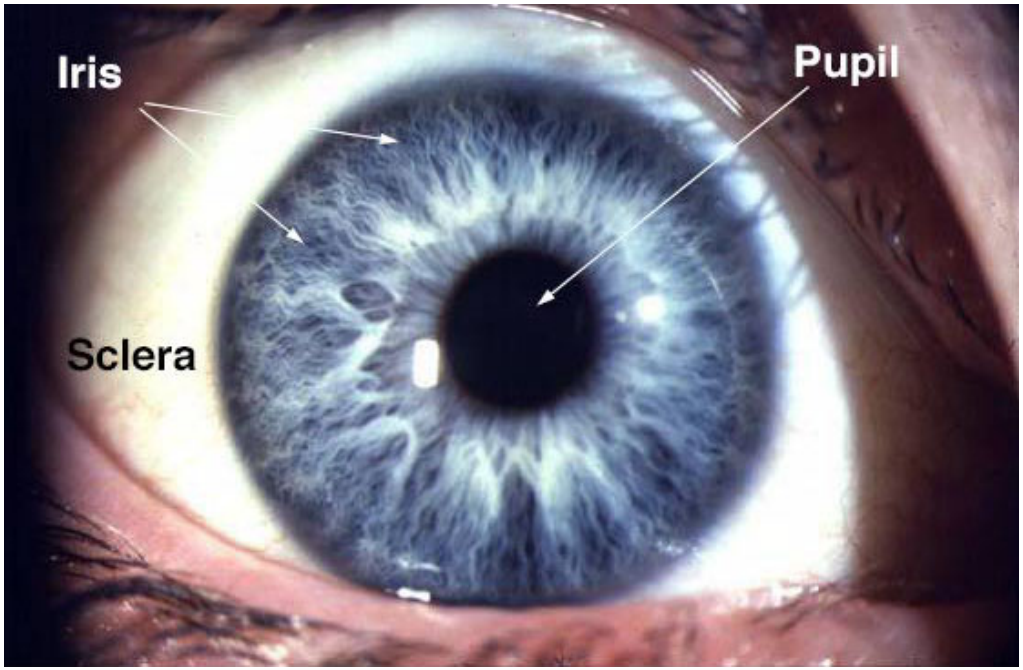
Accommodation (focusing)



Accommodation: Far

Accommodation: Near

Accommodation and the pupil



Far objects

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

Close objects

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

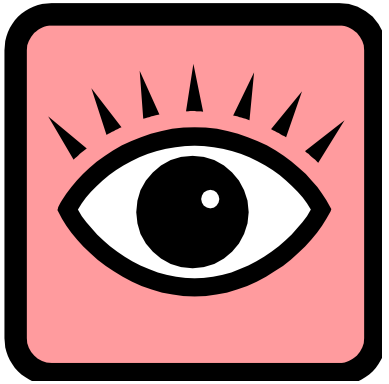
Ever wondered how a camera works?

Camera

- Case
- Lens
- Diaphragm
- Aperture
- Image Sensor

Human Eye

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

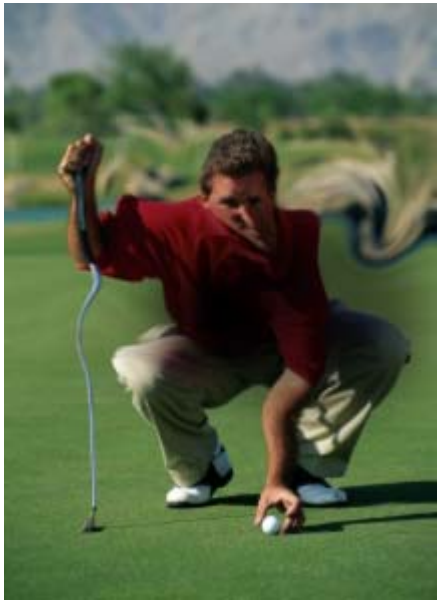


Eye Quiz

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. carries nerve impulses from eye to brain_____Optic nerve_____

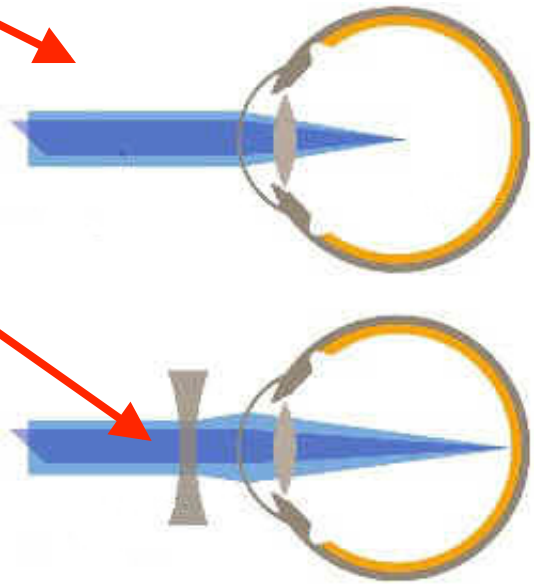
9. spot where optic nerve attaches to retina _____Blind spot
10. interprets visual signals that have been sent from eye_____Occipital lobe
11. liquid maintains eye shape and nourishes cornea _____Aqueous humor
12. transparent portion of eye that covers the front cornea
13. biconvex elastic structure 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

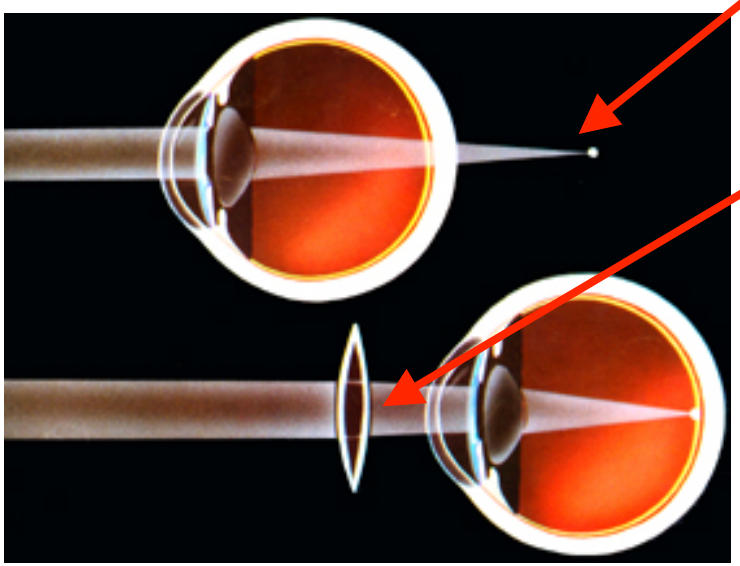


Myopia (nearsightedness)

- 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



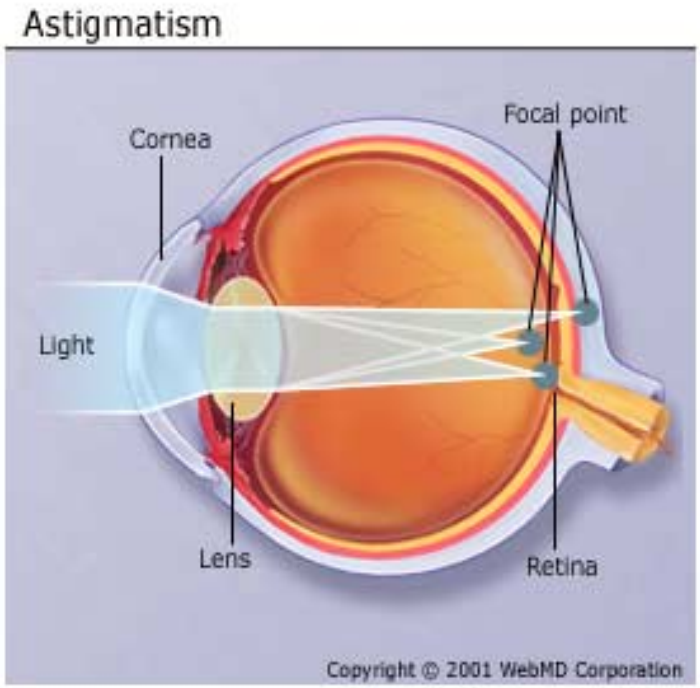
Hyperopia (farsightedness)

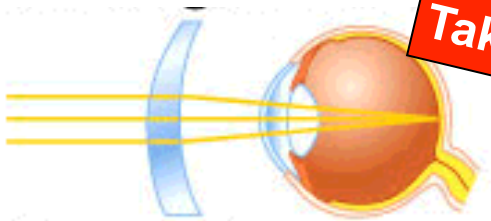


- Can you see near or far?
  - Far
- The eyeball is **too short**, so images are focused **behind** the retina
- Corrected by a **convex** lens

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**

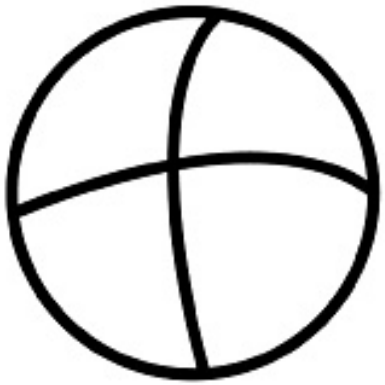




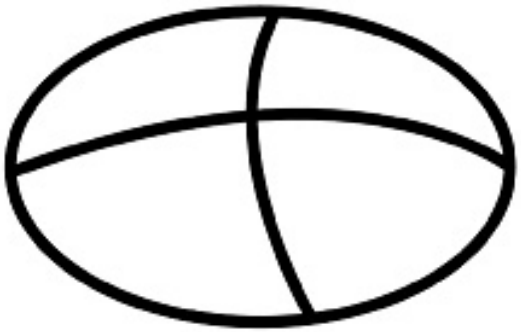
Uneven lens corrects astigmatism

Take the astigmatism test!

Normal cornea



Cornea with astigmatism

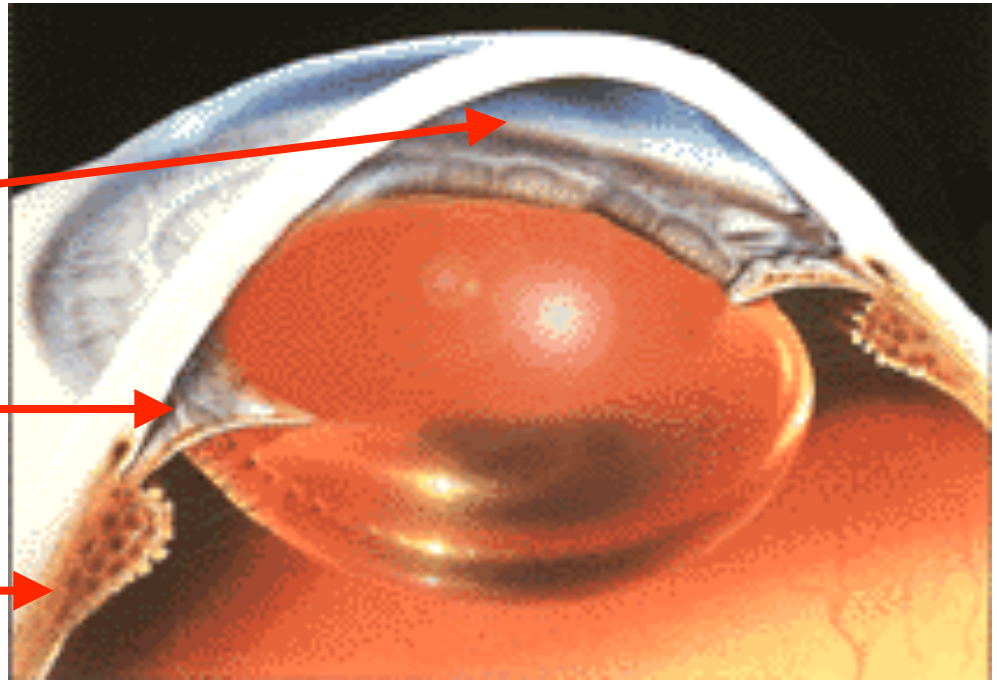


Normal vision

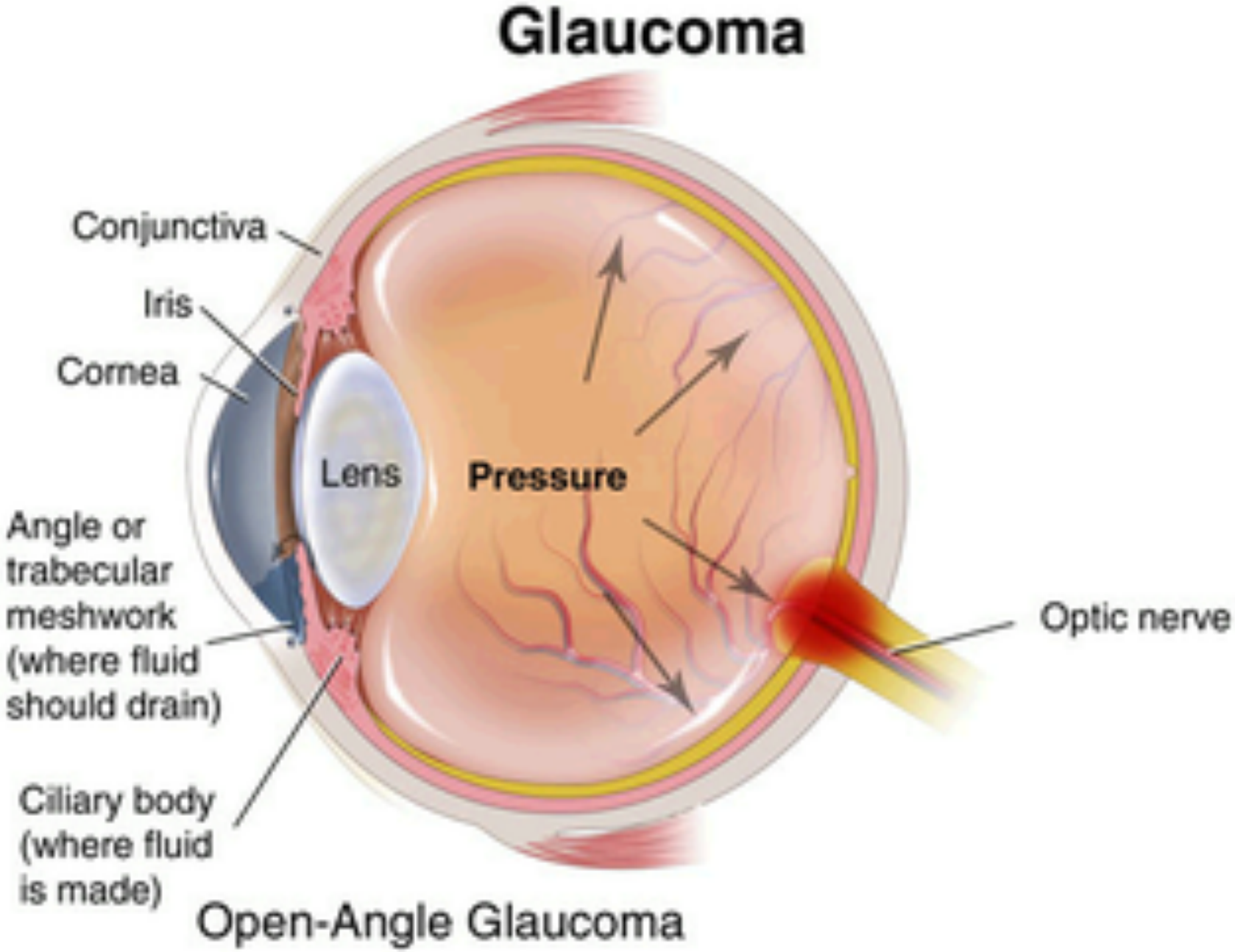
Vision with astigmatism

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



http://www.youtube.com/watch?v=lJwsBXGlf7c


Glaucoma
Conjunctiva
Iris
Cornea
Lens
Pressure
Angle or trabecular meshwork (where fluid should drain)
Ciliary body (where fluid is made)
Optic nerve
Open-Angle Glaucoma

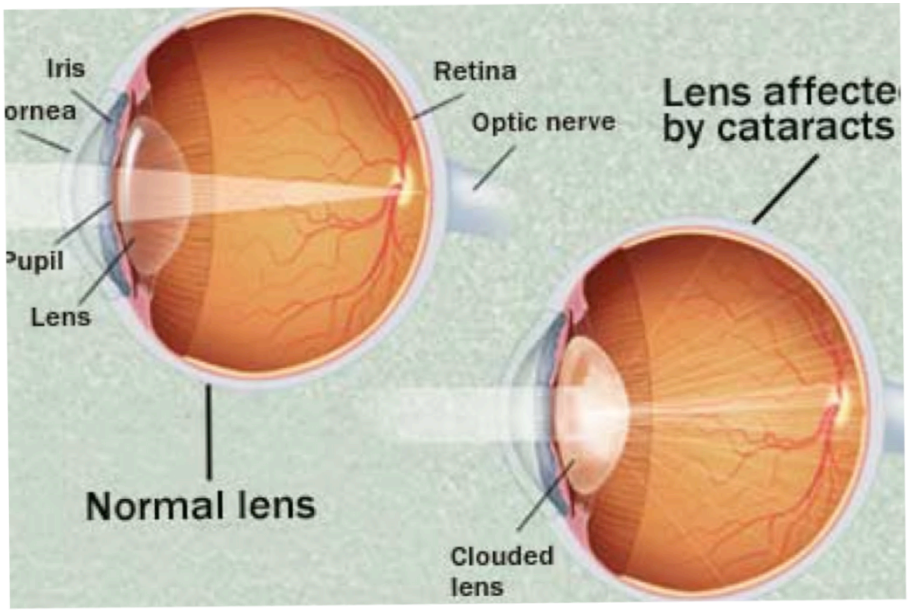
Glaucoma

A gradual loss of side visio
noticeable symptoms of gl

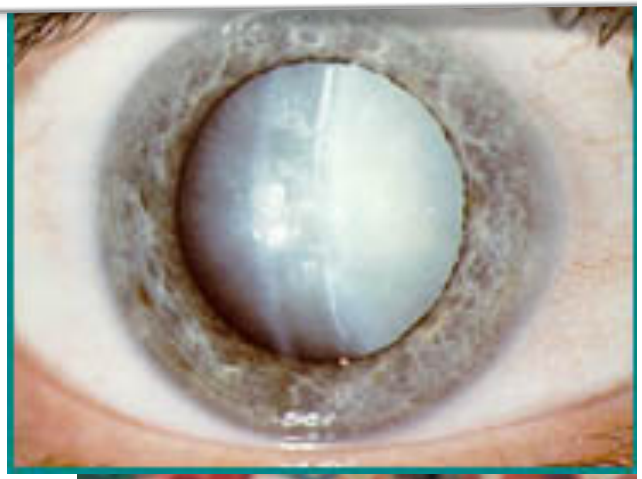
Blurred vision may be another
symptom of glaucoma.

- **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

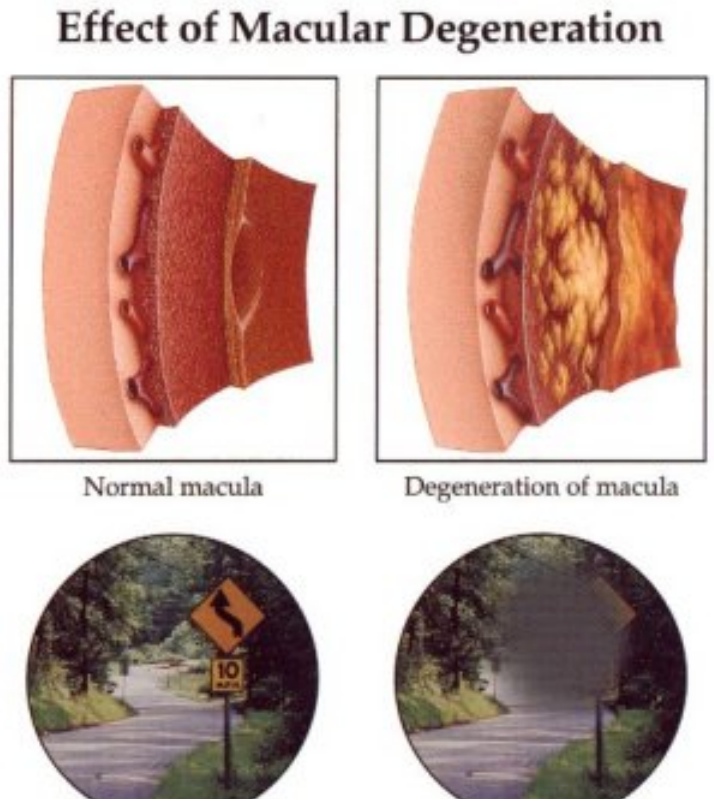


- Lens becomes **cloudy**
- Vision becomes blurry
- Caused by **denaturation** ("cooking") of lens protein (UV light, diabetes, old age)
- Treatment: Remove the lens and replace it with a new one

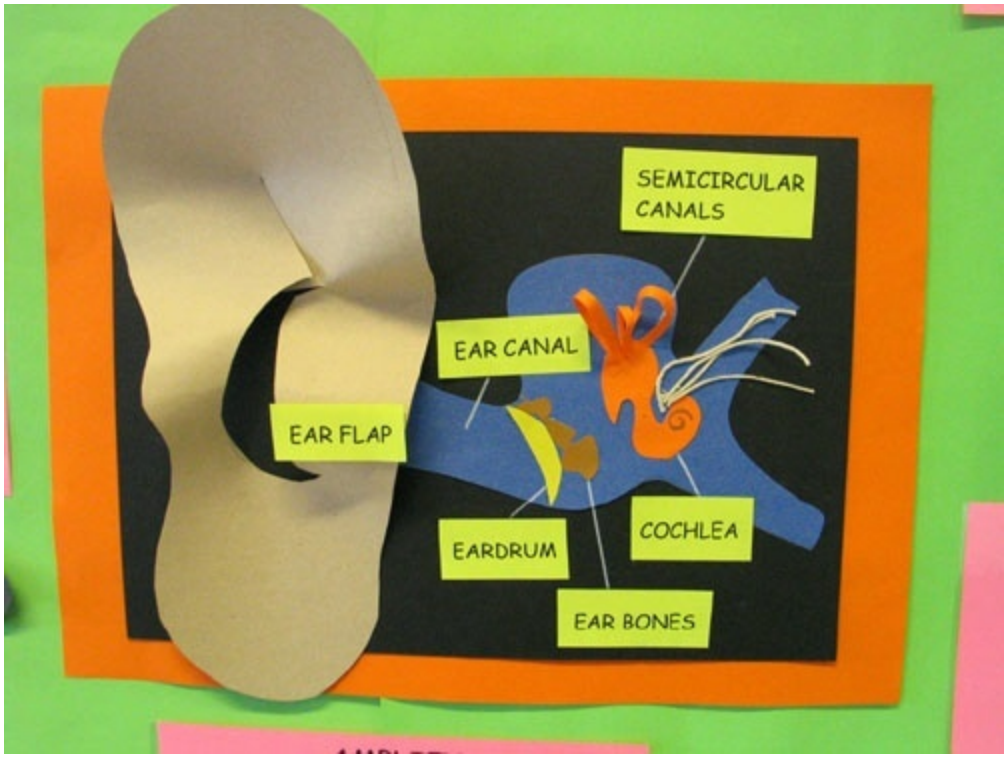


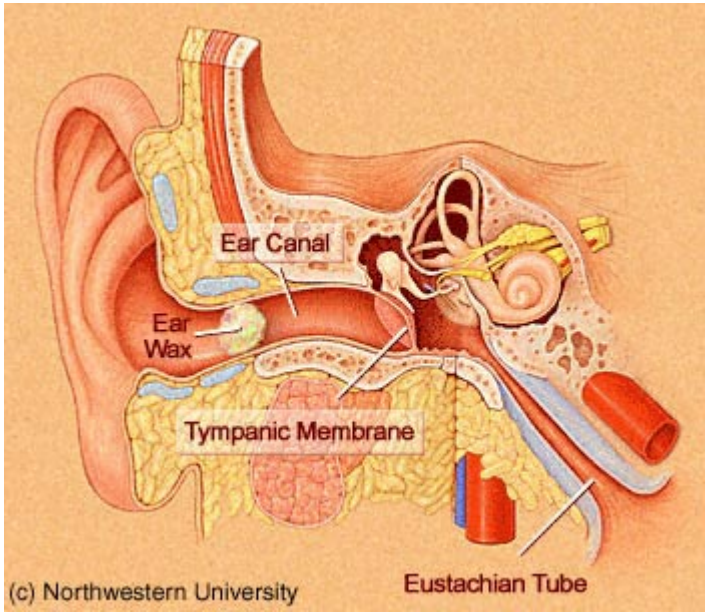
Macular Degeneration

- 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")



Did you hear?

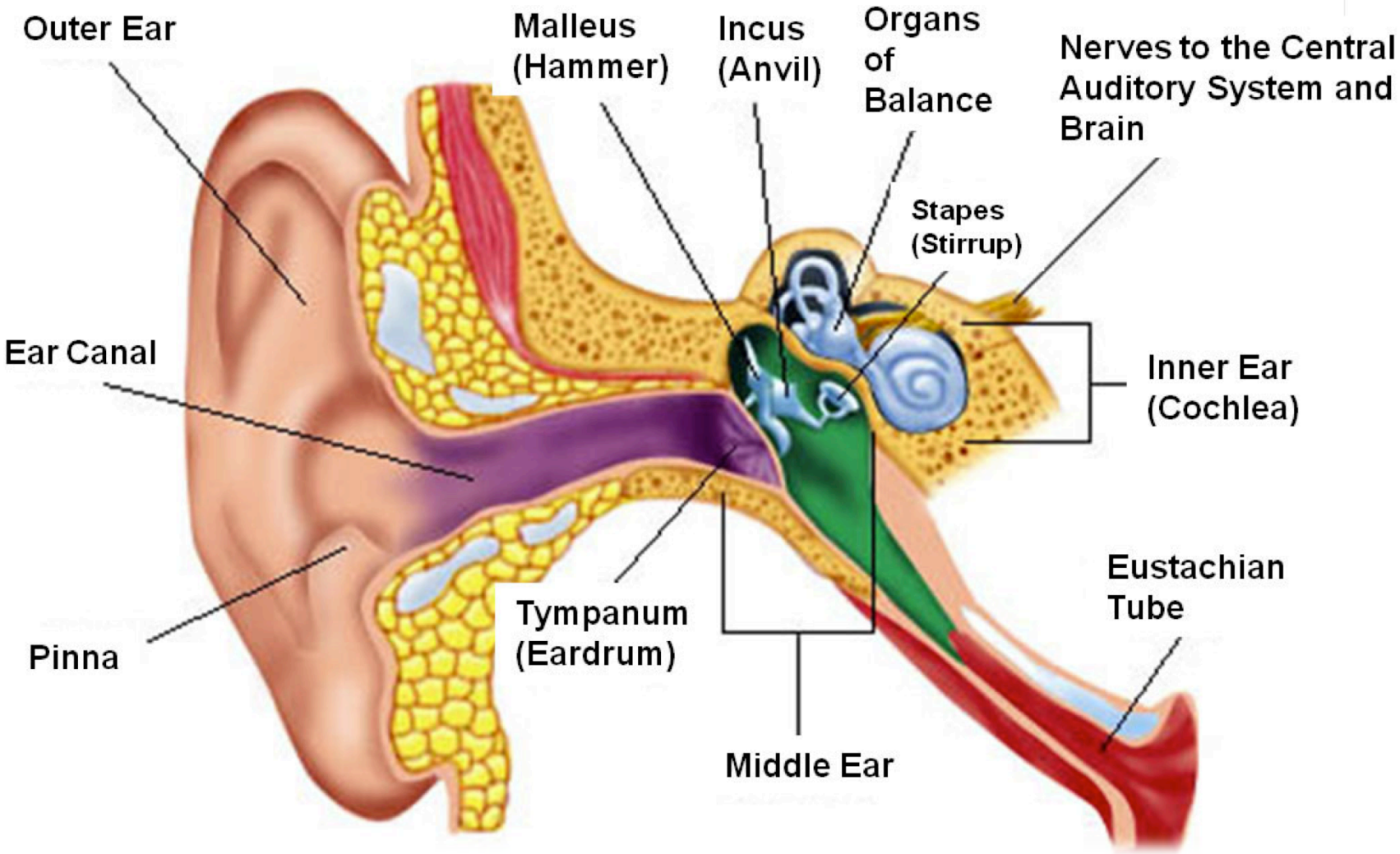




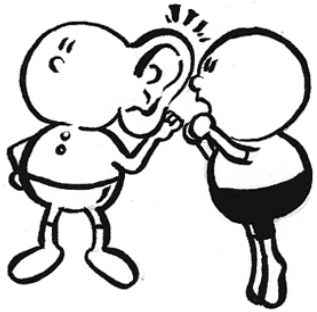
It's all about the ear!

MECHANORECEPTION

THE EAR



Functions



- The ear has 2 separate functions:

  <u>Hearing</u> and <u>balance/equilibrium</u> (dynamic and static equilibrium)

Do you know where the smallest bones in the body are?

**The ear ossicles.
They are fully developed at birth.**

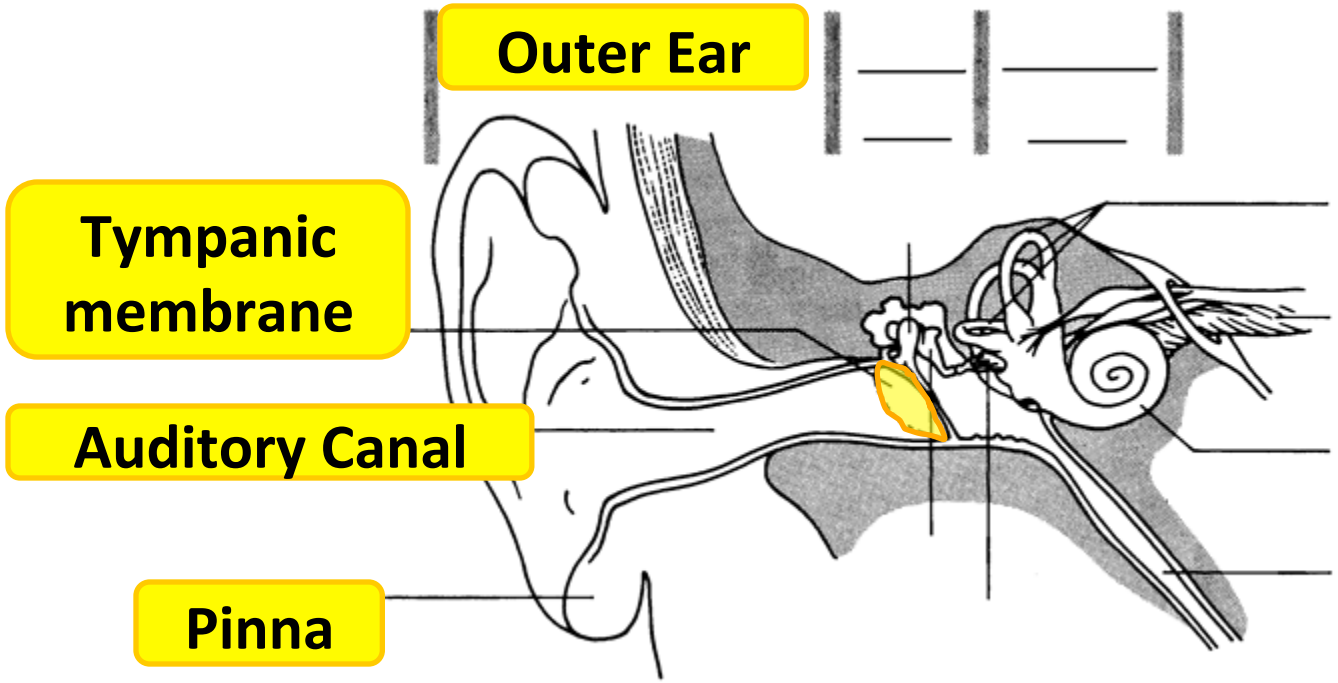
Outer Ear

Amplifies sound

Pinna – external ear flap. funnels sound into ear

Auditory canal – amplifies sound. (makes it louder)

Tympanic membrane (ear drum) - vibrates



How the ear works: (1:33) https://www.youtube.com/watch?v=MXt_gX2Srgo

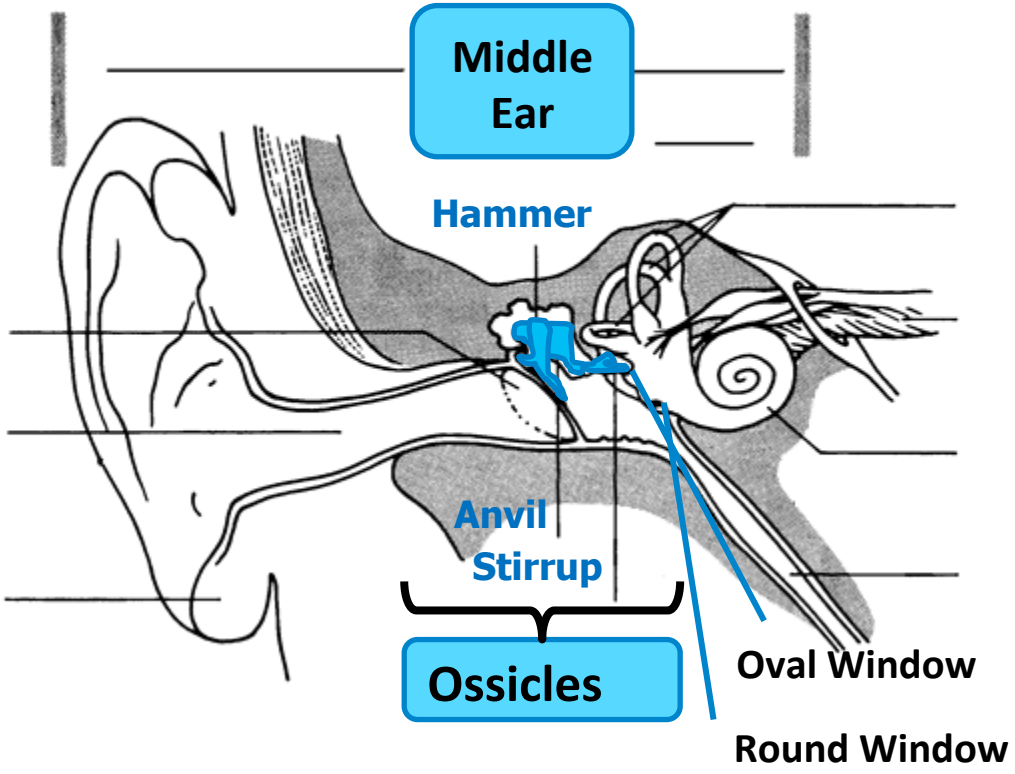
Middle Ear

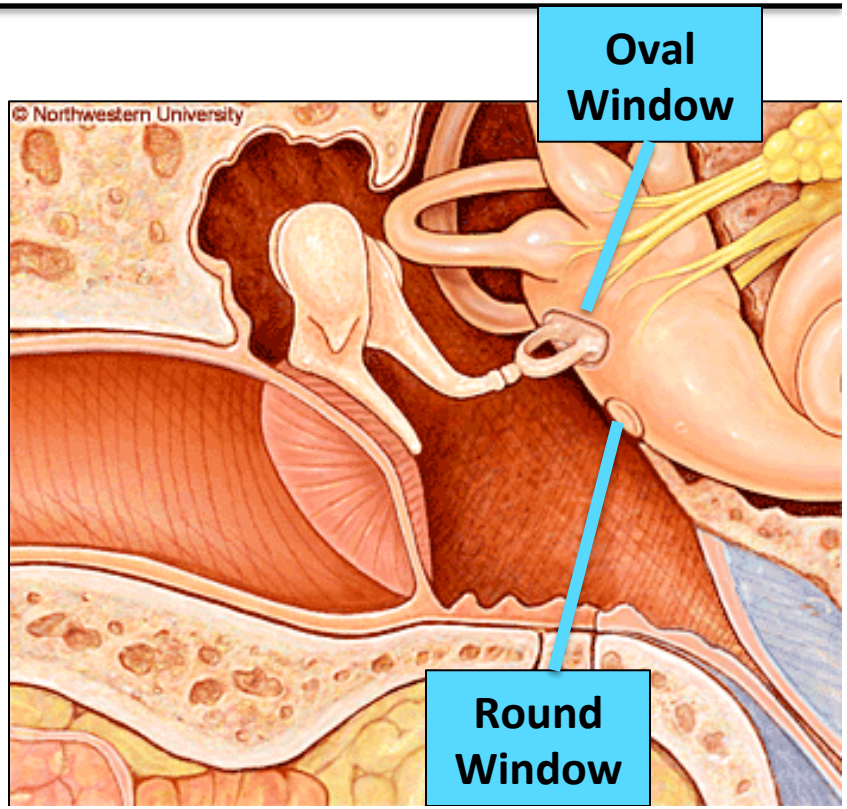
air-filled

Amplifies sound

Ossicles (bones) – vibrate and amplify sound

Oval Window – sends vibrations to inner ear. Smaller than ear drum to amplify sound. As the stapes pushes in on the oval window, the **round window** membrane moves out, and this allows movement of the fluid within the cochlea, leading to movement of the cochlear inner hair cells and thus hearing.





Middle Ear

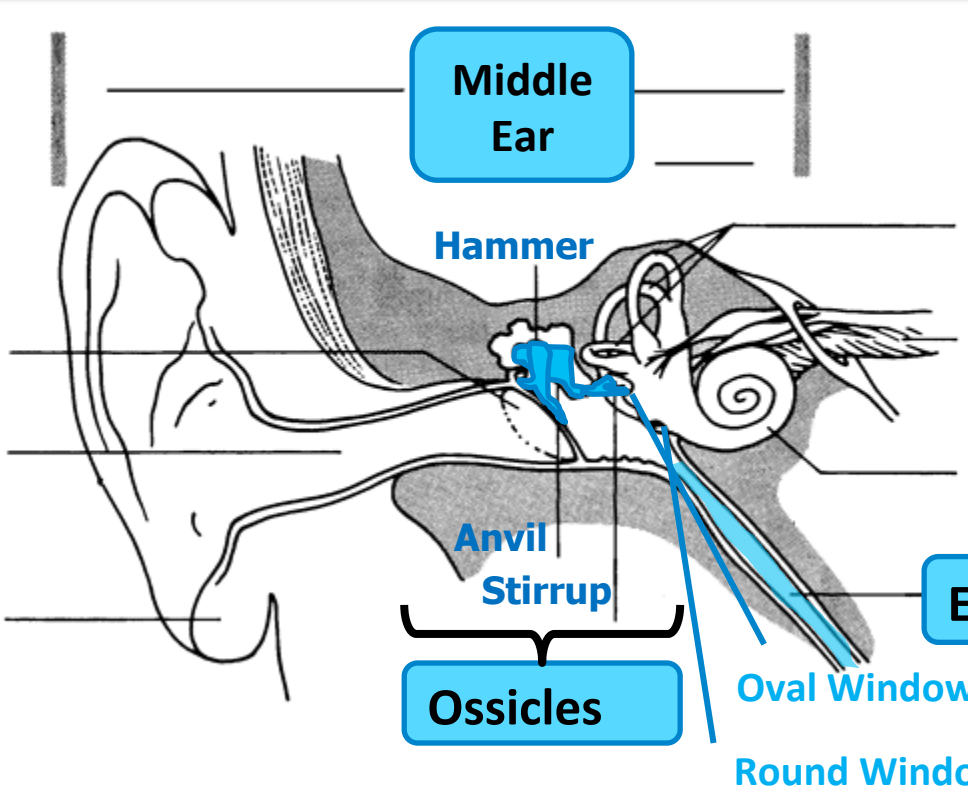
Air-filled

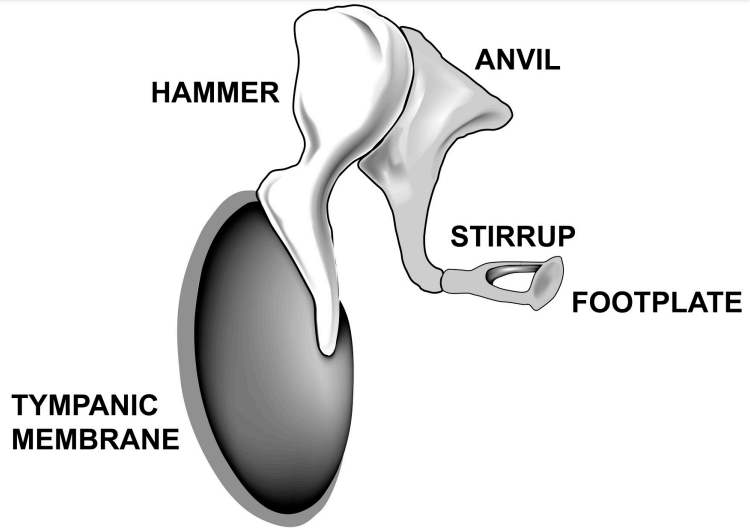
Amplifies sound

Ossicles (bones) – vibrate and amplify sound

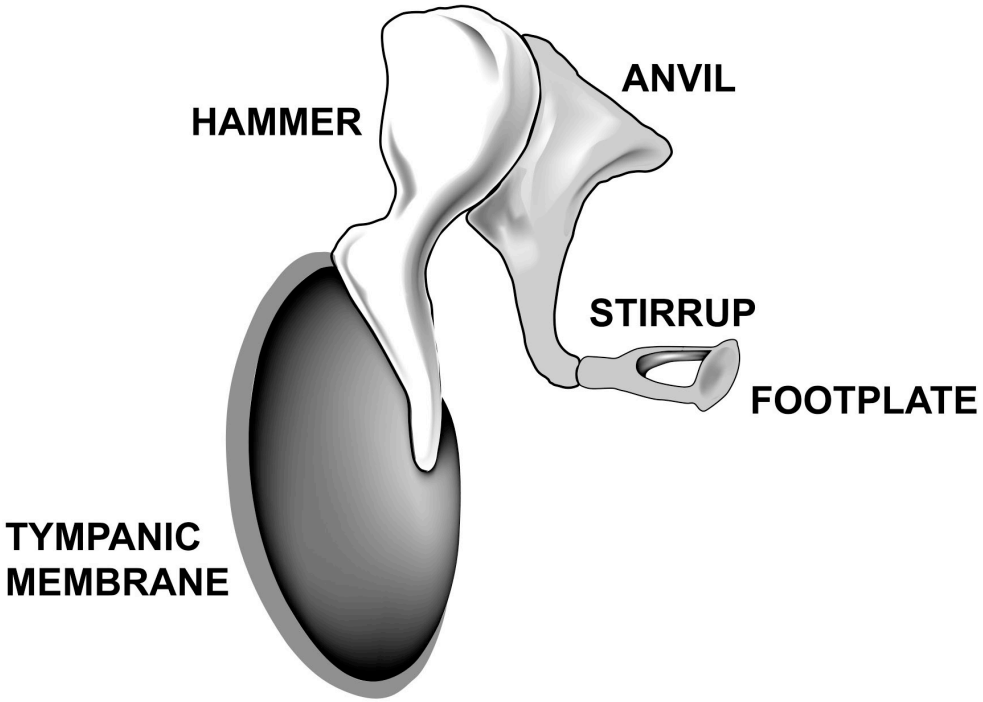
Oval Window – sends vibrations to inner ear.

Eustachian tube – Connects the middle ear to the mouth and nose.
Allows for equalization of pressure between the internal and external ear.
Build-up of liquid in the Eustachian tube can cause deafness and poor balance.



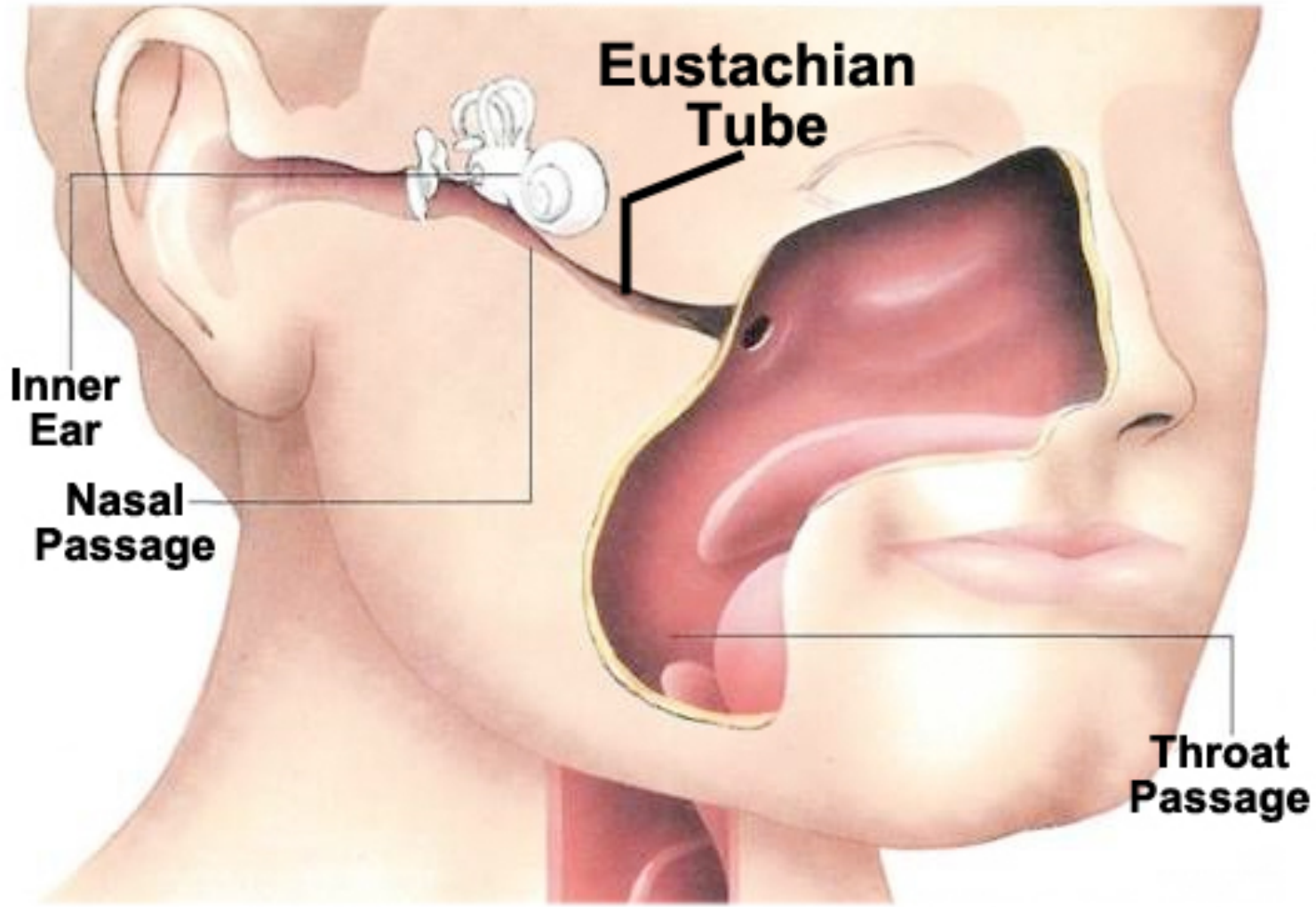


Ossicles: **the ossicles convert sound vibration**
FROM AIR to sound vibration
IN FLUID(within cochlea)



Eustachian Tube

-normally closed, the Eustachian tube will “pop” open to equalize pressure in the inner ear



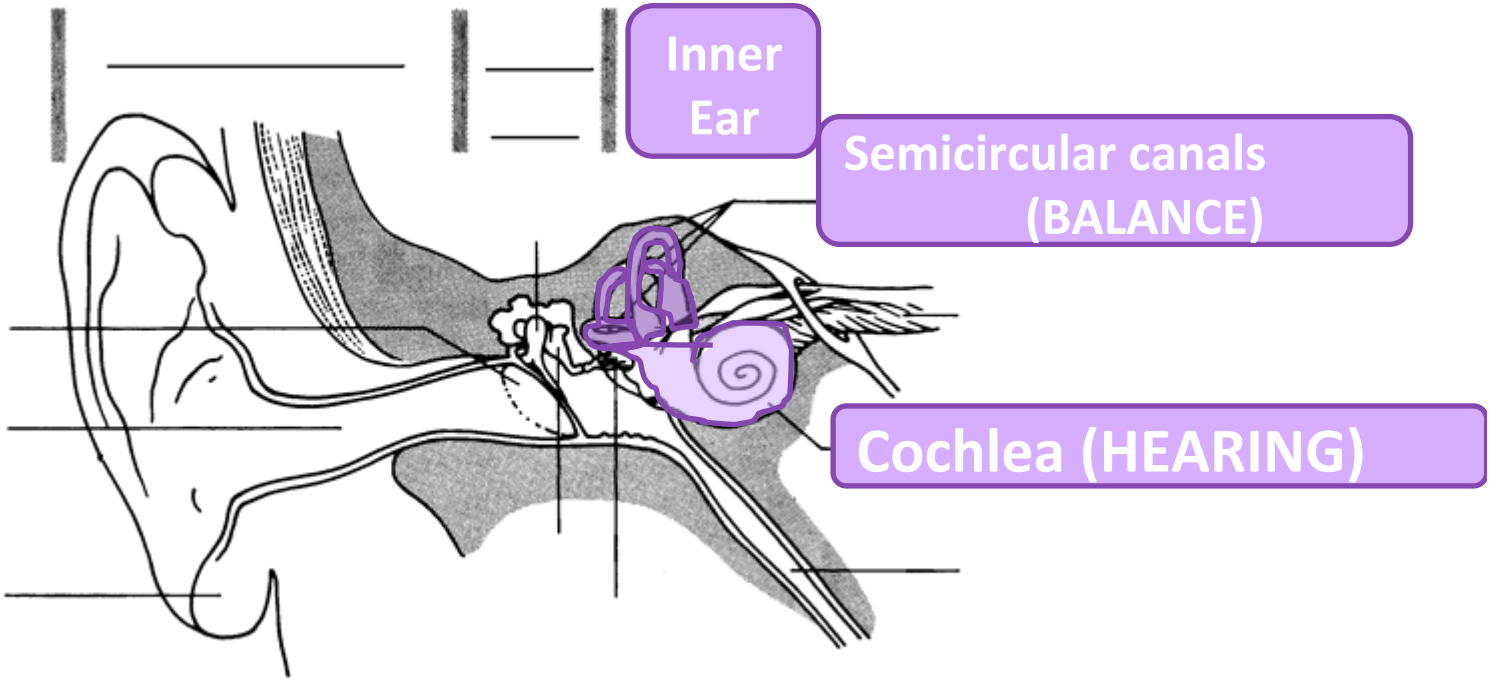
Inner Ear

Fluid-filled

Converts vibrations into electrical impulses

Cochlea (HEARING) Hair cells on the basilar membrane identify sound waves and convert them into action potentials

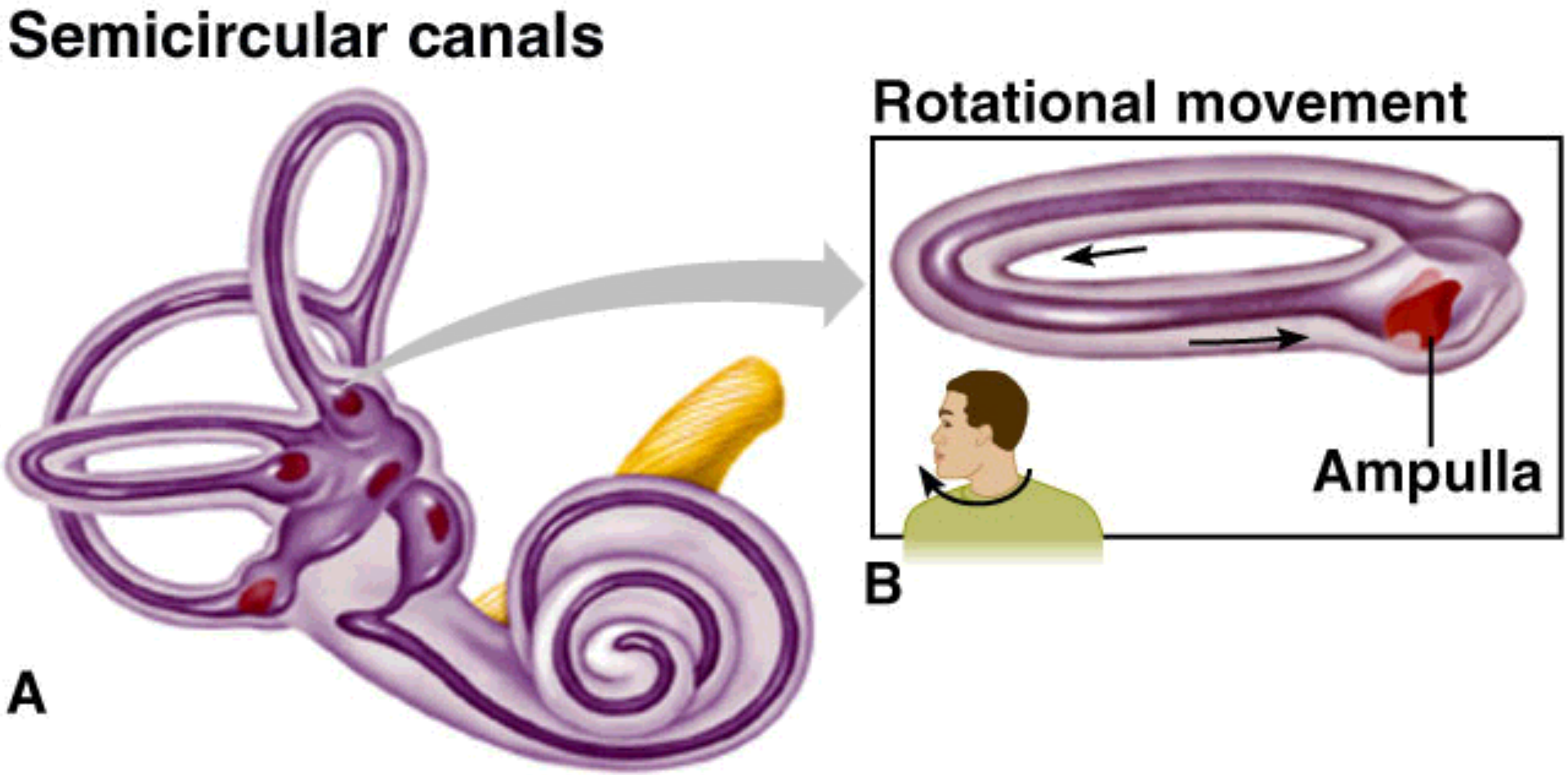
Semicircular canals (BALANCE) Movement of fluid in the canals provides information about body movement **dynamic equilibrium**



Bozeman: Sensory System 10:31
The ear starts at 5:30
http://www.youtube.com/watch?v=TAzTFgPSP1iU

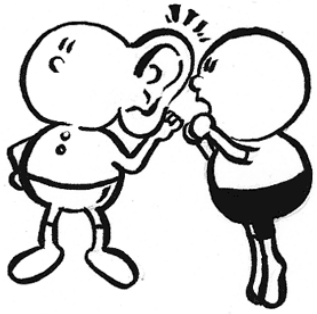
Hearing Animation https://www.youtube.com/watch?v=0NJ_EAQjR3c

Equilibrium and Balance

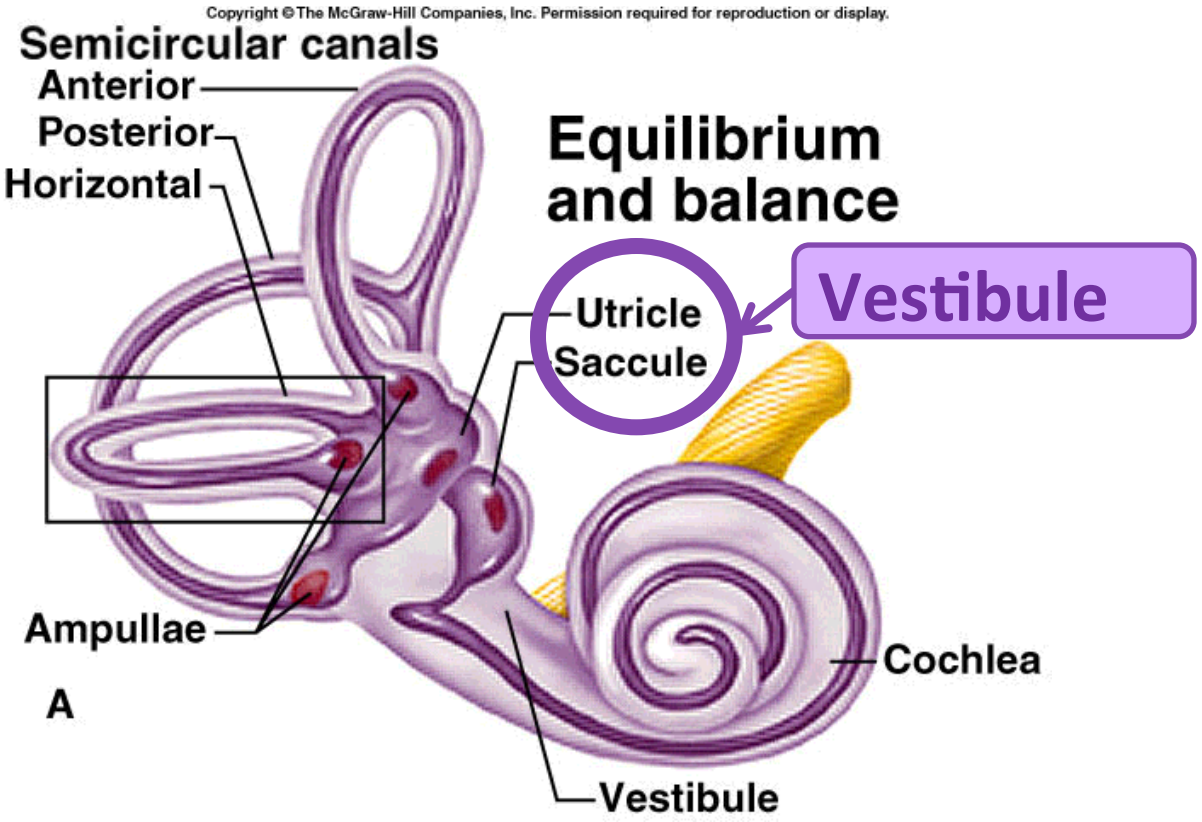


What causes motion sickness?

Inner ear - the vestibule

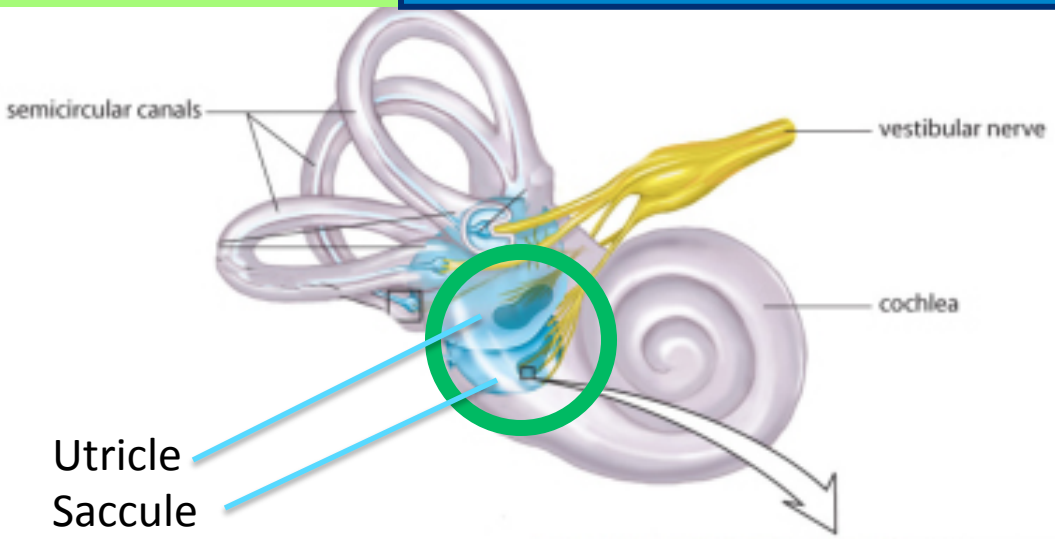


- Found at the **base** of the semicircular canals
- Connected to the middle ear by the oval window
- Provides information about **head position -** **static or gravitational equilibrium**

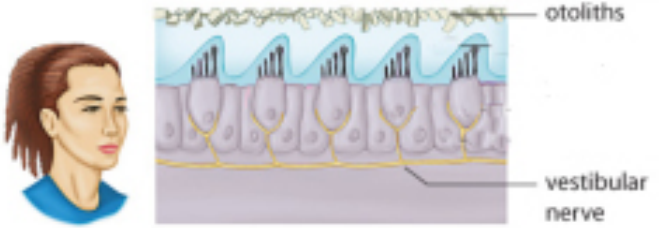


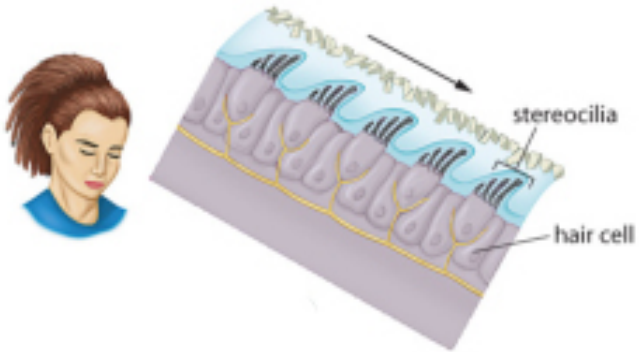
Vestibule

Static or gravitational equilibrium



Utricle
Saccule
=
Vestibule





The utricle and saccule make up the vestibule.

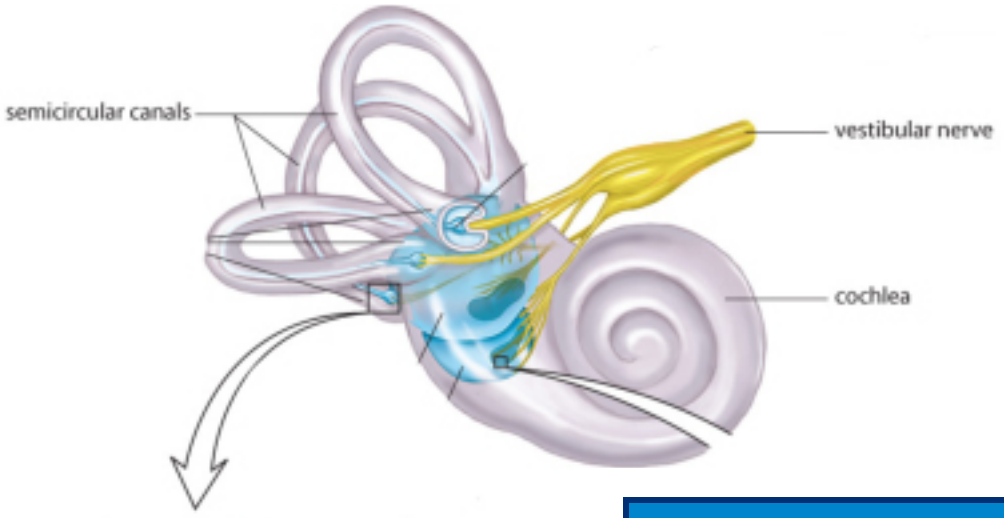
Both of these structures contain calcium carbonate granules, called otoliths.

When the head dips forward or back, gravity pulls on the otoliths.

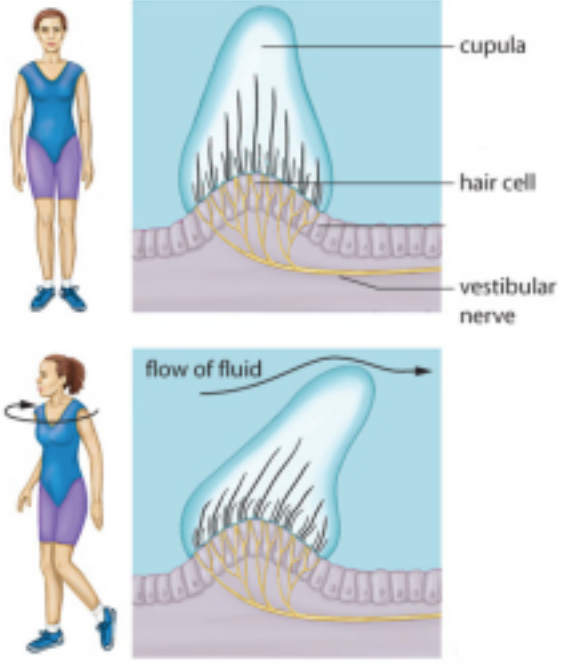
This pulls on the hair cells, causing them to send a neural impulse to the brain.

Semicircular canals

Dynamic or Rotational Equilibrium

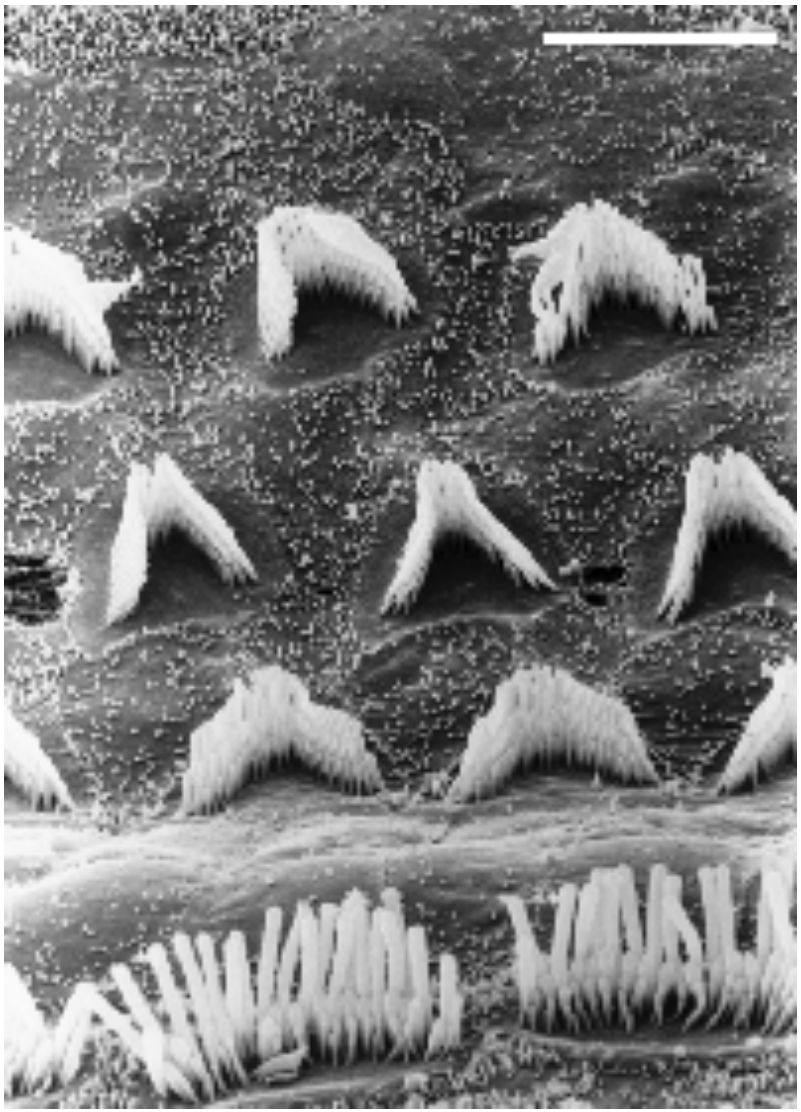


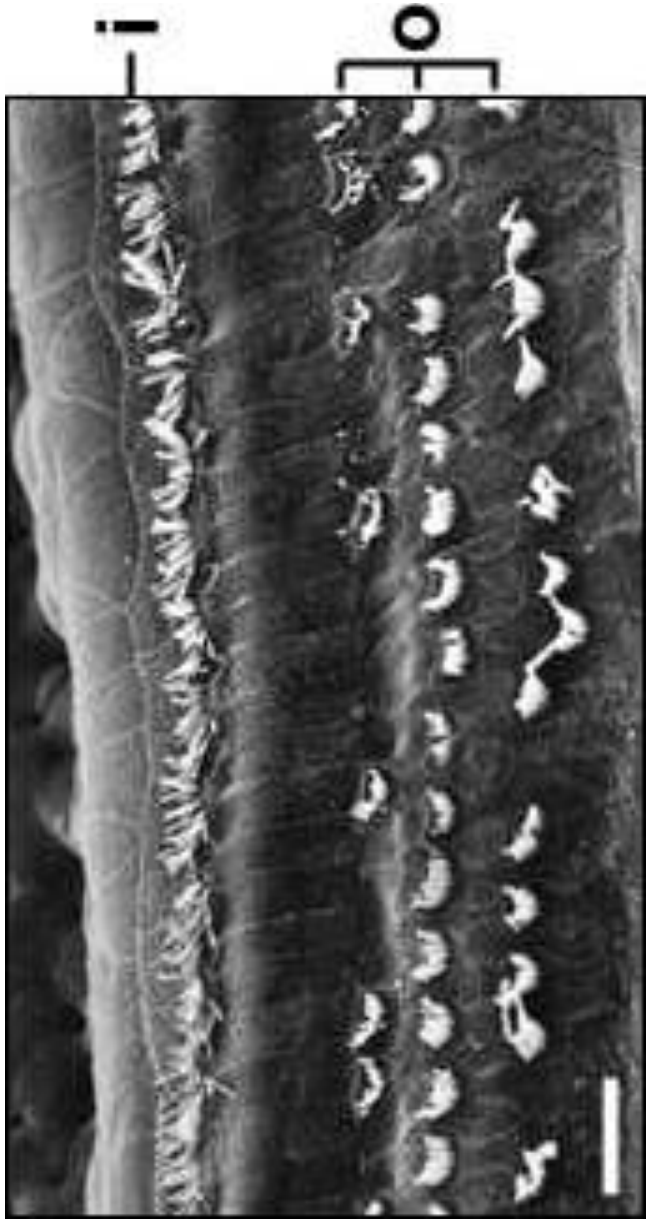
The semicircular canals contain mechanoreceptors that detect head and body rotation.



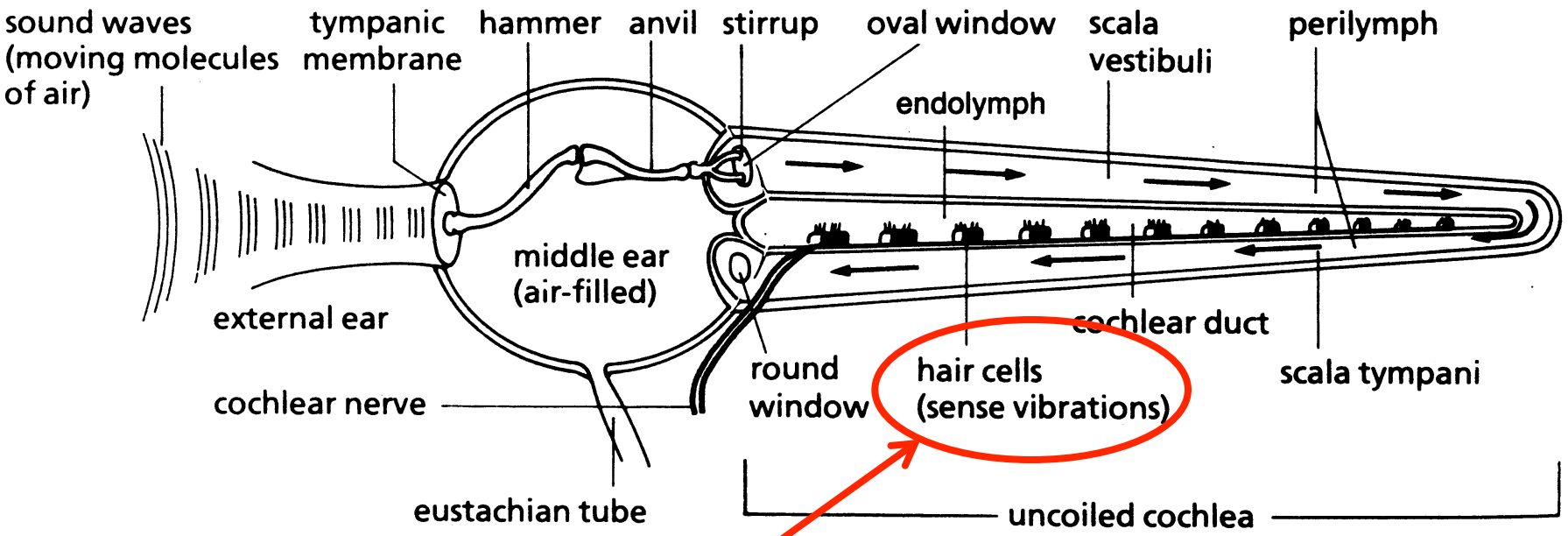
When the head rotates, the fluid inside the semicircular canals moves **and bends the stereocilia in the cupula** causing the **hair cells** to send an **action potential** through the vestibular nerve to the brain**. (cerebellum)**

HOW WE HEAR…



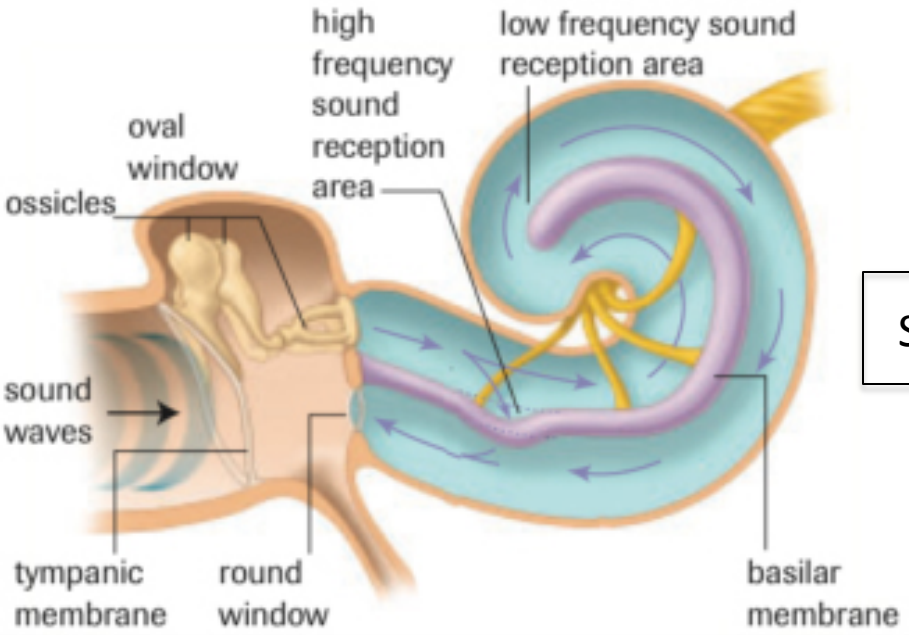


Outer | Middle | Inner

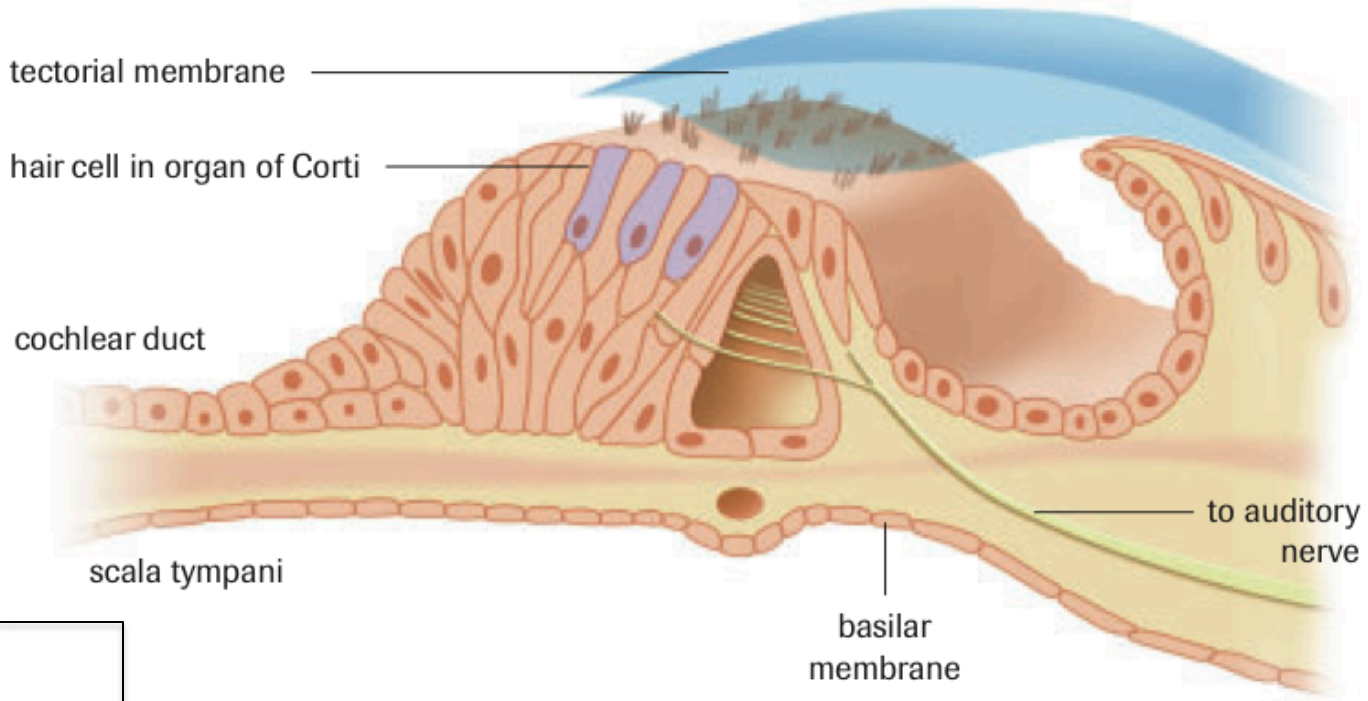


Sensory receptors = convert sound vibrations into action potentials

Page 458 in your text

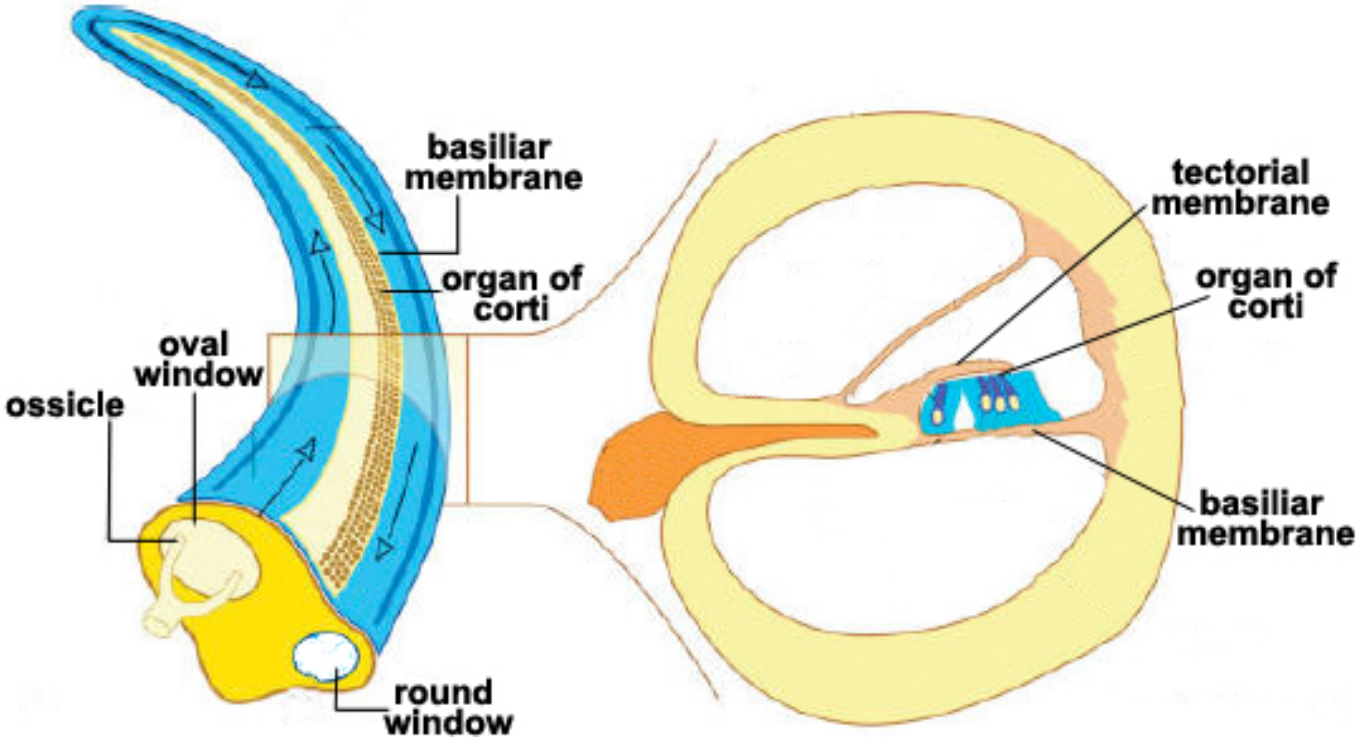


Sound Wave Travel Route in COCHLEA

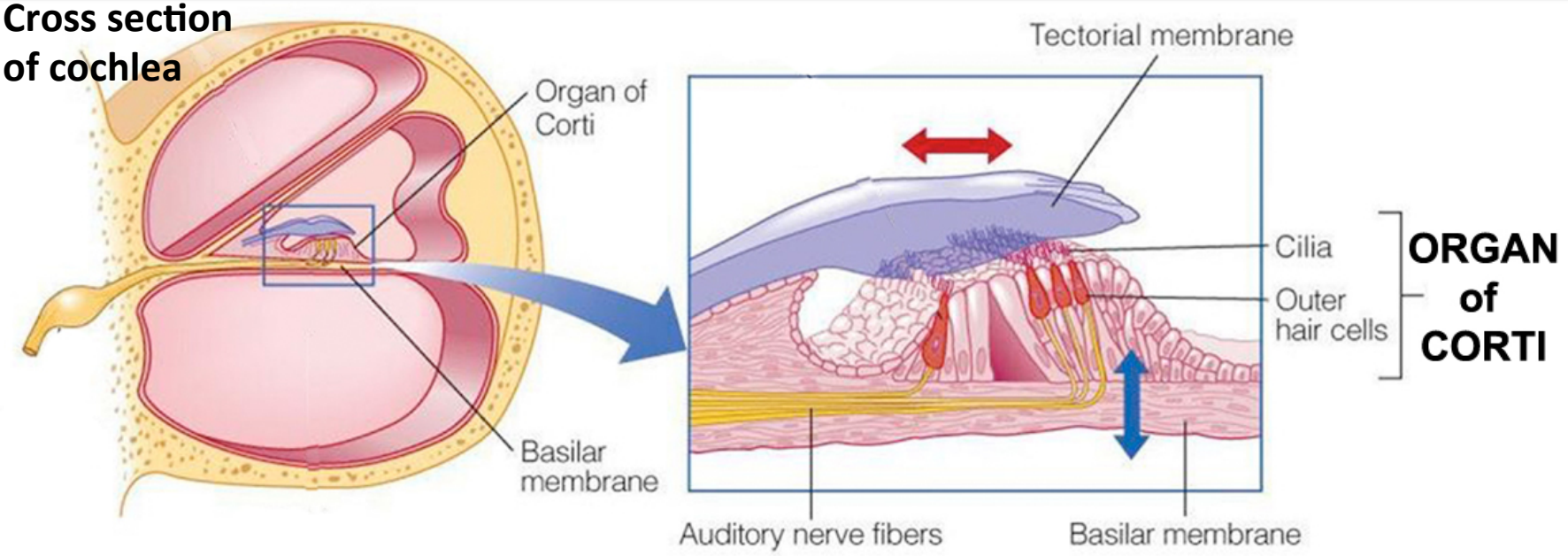


Organ of CORTI

Unwound Cochlea

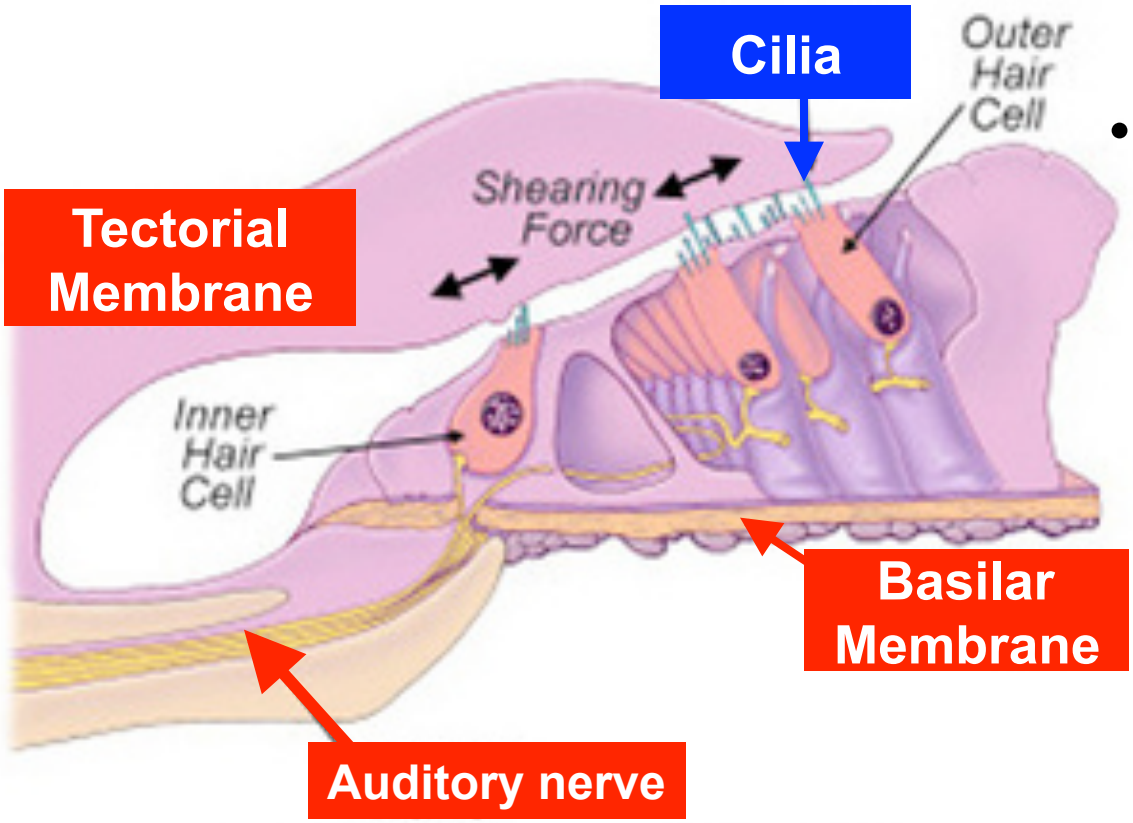


Cross section of cochlea

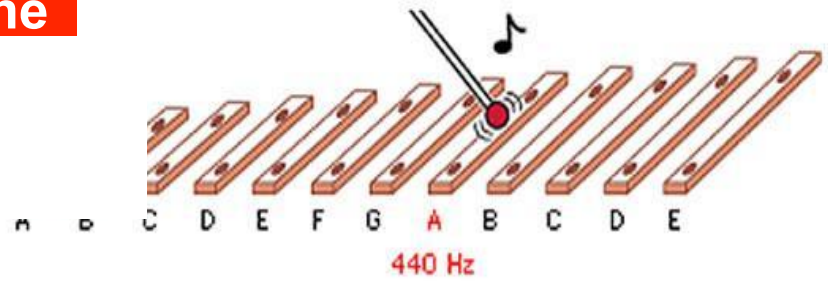


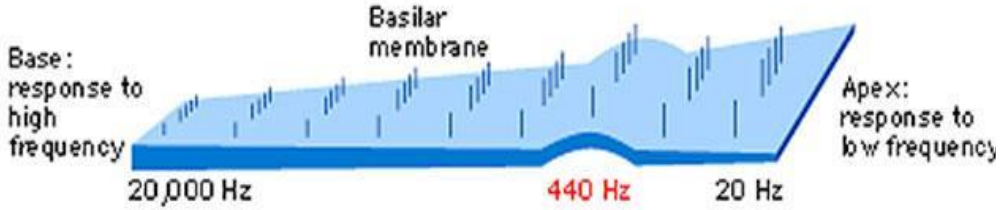
ORGAN of CORTI- the hair cells or cilia

(where hearing occurs)



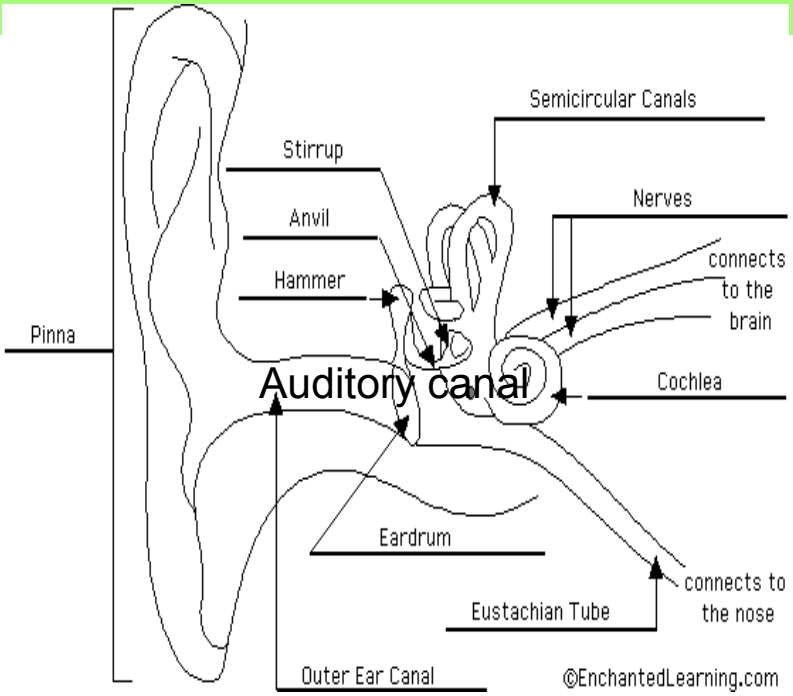
- **Basilar membrane** starts out stiff and narrow and becomes flexible and broad
- **When the basilar membrane moves, it causes bending of the hair cells and action potentials are sent to the temporal lobe of the brain**





Basilar Membrane Movement Video

List the path that sound takes through the ear to the temporal lobe

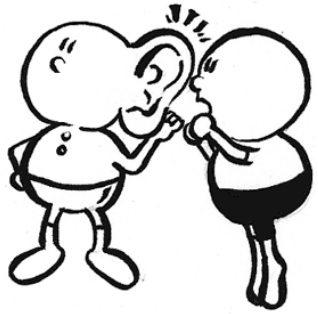


1. Pinna
2. Auditory canal
3. Tympanic Membrane
4. Ossicles
   - Hammer
   - Anvil
   - Stirrup
5. Cochlea
   - Organ of Corti
   - Basilar membrane
   - Hair cells
6. Auditory nerve
7. Temporal lobe

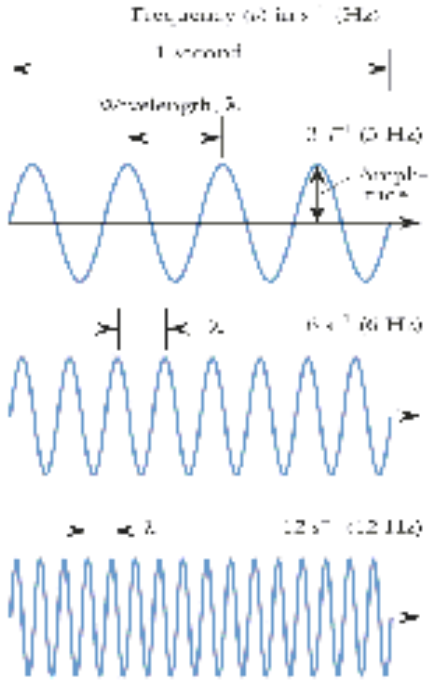
PATOCAT

Auditory Transduction video:
https://www.youtube.com/watch?v=PeTriGTENoc&safety_mode=true&persist_safety_mode=1&safe=active

Pitch and Loudness

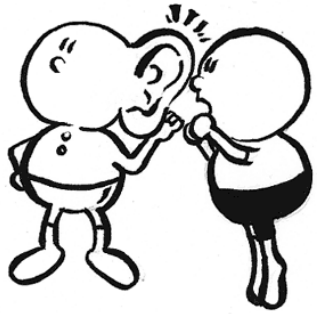


- **Cochlea** is responsible for identifying **pitch** and **loudness**
- The **stiff, narrow basilar membrane** and rigid hair cells detect **high frequency** (pitch) sounds
  - These sounds die faster
- The **wider and more flexible** part of the **basilar membrane** further down detects **low frequency** (pitch) sounds
  - These sounds resonate in the ear



Humans can hear between 20 and 20 000 Hz

FYI: Just how loud is loud?



- Loudness is measured in **decibels (db)**

Click here for an article about iPods and hearing

Sound	Intensity (db)
Ticking of a Watch	20
Whisper	30
Normal Speech	50-60
Car Traffic	70
Alarm Clock	80
Lawn Mower	95
Chain Saw	110
Jackhammer	120
Jet Engine	130

Music above 90 db is said to cause hearing loss

Damage to the hair cells of the inner ear causes hearing loss

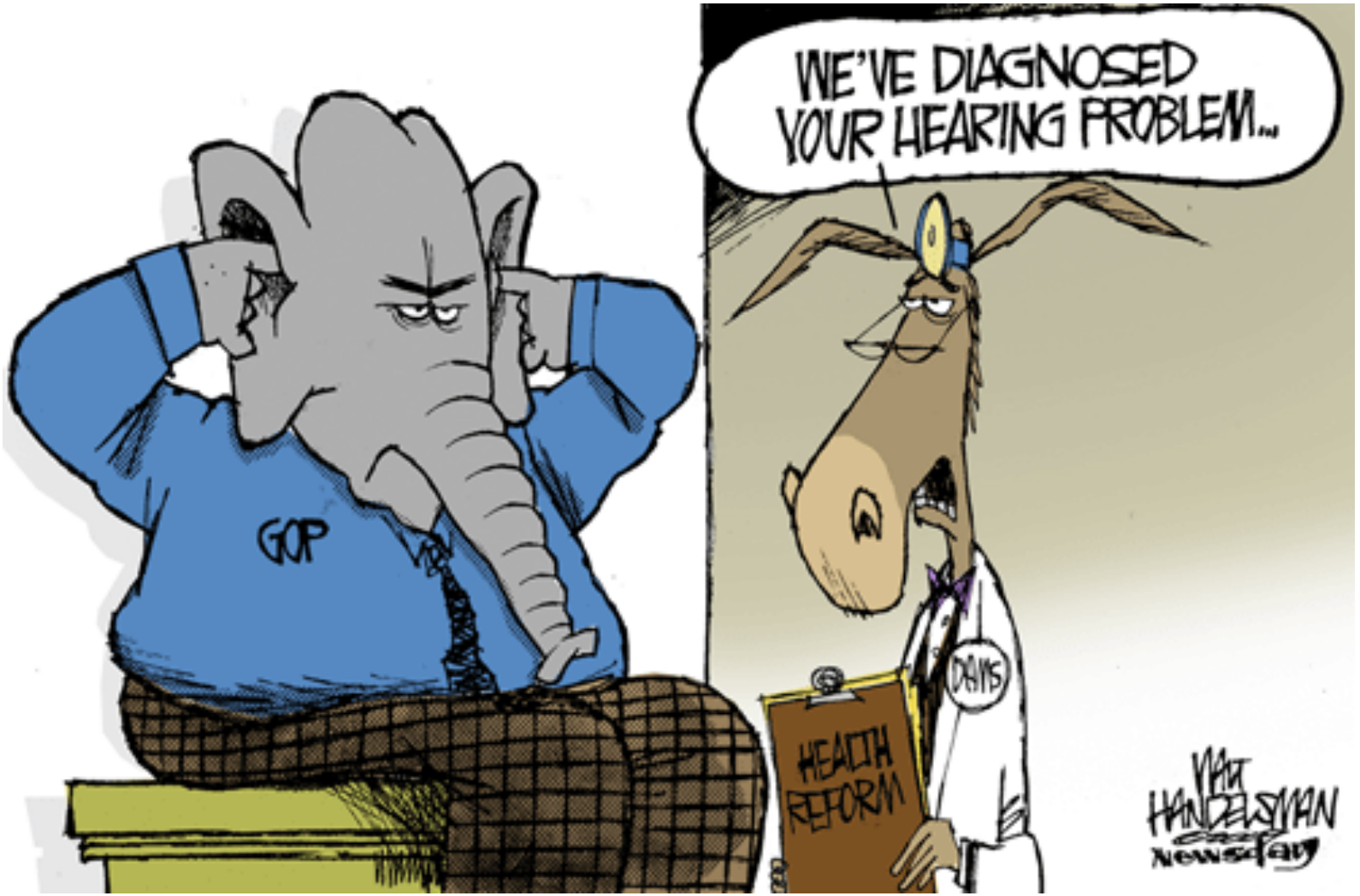
Reasons for Hearing Loss

Conductive causes: blockage of the ear canal.

Sensorineural causes: damage to the hair cells or nerves.

Prolonged exposure to **LOUD NOISES** causes the hair cells on the cochlea to become less sensitive or damaged.

Ototoxic drugs - Certain drugs can affect hearing by damaging the nerves involved in hearing. Antibiotics, aspirin, ibuprofen.


WE'VE DIAGNOSED YOUR HEARING PROBLEM...
GOP
DEMS
HEALTH REFORM
MATT HANDELSMAN
Newsday

Treatments for Hearing Loss

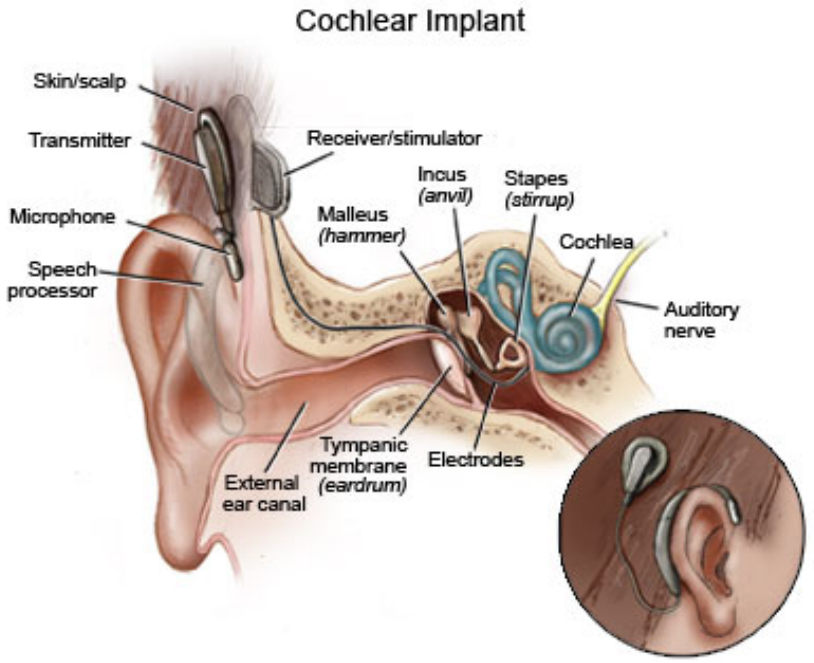
1. If a foreign body is found in the ear canal, the doctor will try to **take it out.**
2. People with conductive hearing loss can have the middle ear reconstructed by an ear, nose, and throat specialist. (**surgery**)
3. **Hearing aids** are effective and well tolerated for people with conductive hearing loss.
4. People who are profoundly deaf may benefit from a **cochlear implant.**

**"My wife said I don't listen to her.
At least I think that's what she said."**

Being hard of hearing made Ursula every pharmacy customer's worst nightmare.

Cochlear Implant

A small complex electronic device that is surgically placed (implanted) within the inner ear to help persons with certain types of deafness to hear.



A cochlear implant has four basic parts:

1) a microphone, which picks up sound from the environment;
2) a speech processor, which selects and arranges sounds picked up by the microphone;
3) a transmitter and receiver/stimulator, which receive signals from the speech processor and convert them **into electric impulses**; and
4) electrodes, which collect the impulses from the stimulator and send them **directly to the brain.**

Baby hears for first time

https://www.youtube.com/watch?v=HTzTt1VnHRM

Cochlear Implant

What parts of the ear do the 4 parts of the cochlear implant correspond to?

A cochlear implant has four basic parts:

1) a microphone, which picks up sound from the environment;

Pinna, auditory canal, tympanic membrane

2) a speech processor, which selects and arranges sounds picked up by the microphone;

Cochlea or Organ of Corti

3) a transmitter and receiver/stimulator, which receive signals from the speech processor and convert them into electric impulses; and

hair cells

4) electrodes, which collect the impulses from the stimulator and send them to the brain.

Auditory nerve