

The Eye and Vision

eye might be considered our most important sense organ

of all the nerve fibers making up the 12 pairs of cranial nerves:
38% of them are contained in the optic nerve

we usually use data from our other senses only to supplement visual information

Physiology of Vision

light is electromagnetic energy
→ spectrum of energies (400nm to 700 nm)

what we "see" is the light that bounces off of various objects and enters our eyes
ie. light that is not absorbed by an object

for vision to occur:
→ an image must be formed on retina stimulating photoreceptors
→ nerve impulses must be conducted to occipital lobe of cerebral cortex
→ must result in conscious perception of image

a clear image is formed on the retina by following processes:

1. Control of Light Intensity

amount of light entering eye must be regulated to allow enough in to stimulate receptors

while preventing too much that might cause overstimulation

A. Pupillary constriction and dilation

pupil = opening in center of iris muscle

iris acts as "f-stop" of camera

allows appropriate amount of light to enter eyeball

prevents overstimulation of retina in daytime
→ prevents extraneous rays that cannot be focused from entering eye
→ or reduces the amount of stimulation of retina

allows adequate light in at night
controlled by autonomic NS:
constr → parasympathetic
dilation → sympathetic

B. choroid layer

also helps absorb excess light

albinos → no pigment in choroid layer
→ difficulty in daylight

2. Refraction of light rays

as light passes through materials of different density and curvatures it is bent (=refracted)

eg. spoon in glass of water

light rays are bent as they pass through cornea, aqueous humor, lens, vitreous humor

also image is reversed

if everything is normal the eye is designed to cause image to converge on the back of the eye

creates **visual field** on retina

in many the eyeball is not shaped properly to get image to converge on retina:

nearsightedness
farsightedness

astigmatism – bump or depression on cornea or lens that refracts light rays incorrectly

3. Accommodation of Lens

in order to be able to focus on near or far objects
the lens must change shape (similar to adjusting lenses on camera)

normal eyes can adjust focus by changing shape of lens to see both near and far

accomplished by **ciliary muscle** and **suspensory ligaments**:

contraction

- release tension on lens
- lens thickens for near vision

relaxation

- pulls suspensory ligaments and pulls on lens
- causes lens to thin for far vision

4. Depth Perception (Convergence of Eyes)

extrinsic eye muscles and reflex centers in brain
allow individual eyes to converge on same object

would produce double vision if both eyes are not focused on same scene

those with crossed eyes learn to suppress one image

produces depth (3-D) perception

- both eyes are looking at same scene but from slightly different angle

those with only one eye have no depth perception

5. Stimulation of photoreceptors

>130 Million photoreceptors in each eye

two types of photoreceptors:

rods

cones

rods: contain pigment = **rhodopsin**
(derived from vitamin A)

when light strikes pigment

- causes chemical change
- triggers nerve impulse

rhodopsin then reforms and is ready to be stimulated again

cones: also contain pigments
three kinds of cones:

erythrolabe (red)
chlorolabe (green)
cyanolabe (blue)

combinations of the three produce color vision
→ eg. all 3 = white

switching between 2 different receptors can cause temporary blindness
eg. turn off or on lights
→ receptors must adapt

in daytime, rods "bleach" out & shut down
at night – not enough light to stimulate cones

Rods	Cones
b/w vision 100's x's more sensitive → takes less light to stimulate them night time, low light vision less acute vision (many rods/ neuron) periphery sharpest vision	color vision less sensitive to light → takes more light to stimulate them day time, high light vision more acute vision (1 cone/ neuron) fovea sharpest vision

once receptors initiate nerve impulse
→ conducted to visual area of occipital lobe
optic nerve
optic chiasma
optic tract

left visual field processed in right brain
right visual field processed in left brain

injury to eg. rt optic tract
→ see in both eyes but only partially

Disorders of the Eye

an American goes blind every 11 minutes (AAS 1994)

Macular Degeneration

loss of central field of vision; sometimes loss of side vision usually both eyes

inability to see clearly near or far

in advanced stages objects seem bent or distorted

colors may look different

supporting tissue around macula degenerates

associated with arteriosclerosis, hereditary factors, eye trauma

most common for Caucasians, people >60; rare among blacks

diagnosed early → laser treatments may prevent further degeneration

Glaucoma

slow loss of peripheral vision, no pain in early stages

later may be pain and blindness

due to increased pressure in eye leads to damage to optic nerve

blacks at much higher risk; also diabetics those with eye injuries or eye surgeries or very near sighted

if diagnosed and treated early may be no injury; but half with glaucoma don't know they have it

Floaters

small spots seen occasionally in field of view; spots appear as dots, threads or cobwebs that move as eye moves

caused by shrinkage of vitreous, which detaches from retina causing bleeding

sometimes result from eye injury or disease

those >40 more susceptible, also those with cataract surgery

Diabetic Retinopathy

progressive disease of blood vessels supplying retina

→ small blood vessels weaken and break or are blocked

esp in diabetics; more common in long term diabetics(>15 yrs) pregnancy, high BP and smoking can exacerbate condition

Cataracts

clouding of lens

blurred or double vision, spots, ghost images, impression of a film over eyes, problems with lights

may develop rapidly over a few months or very slowly over period of years

exact cause unknown

age related, diabetics, some medications and eye injury may increase risks; may be genetic component

treatment: cataract surgery – quick outpatient procedure; then lens implant, contact lenses or cataract eyeglasses