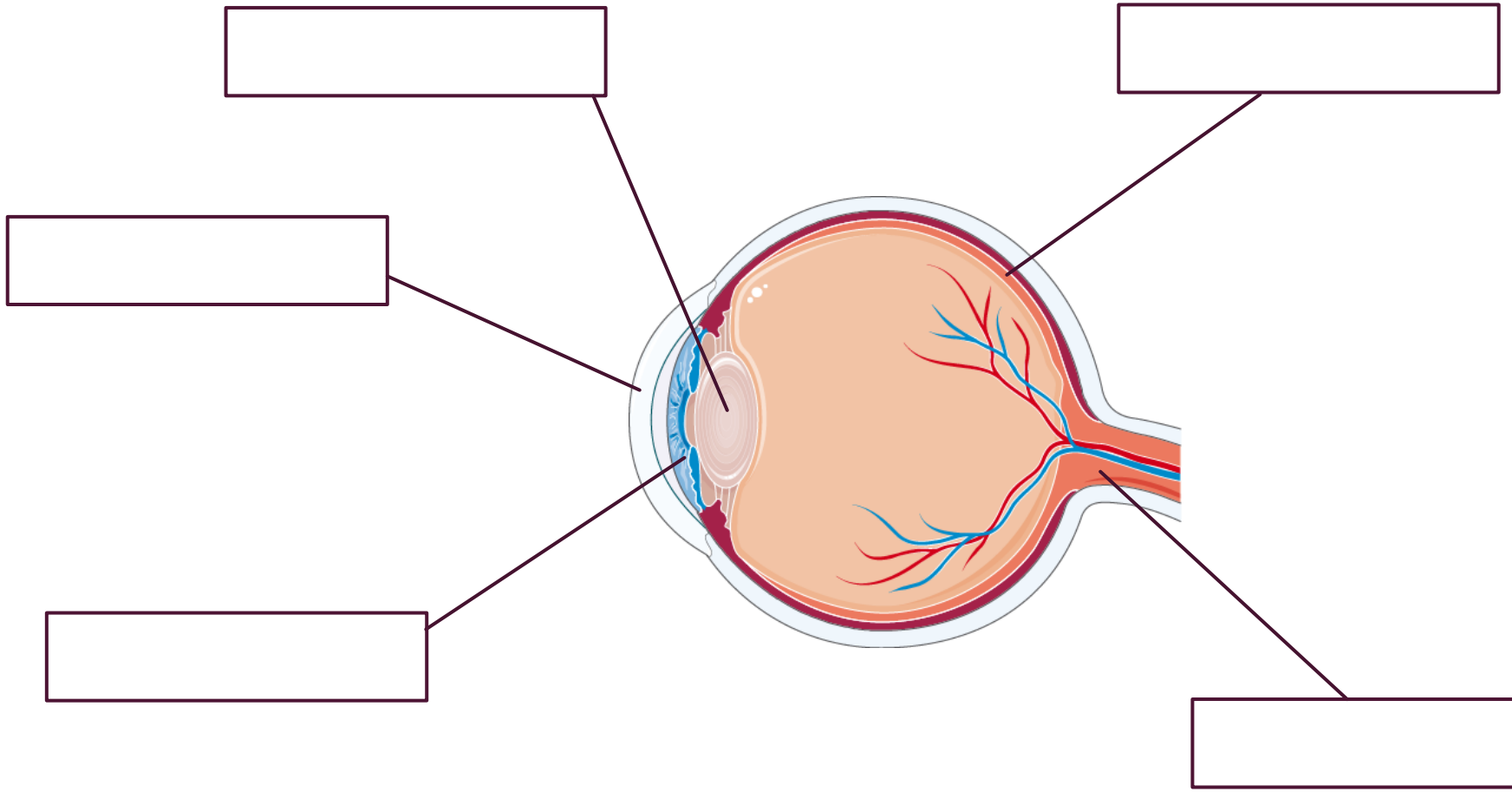
EYES IN SCIENCE

MARIA CHIARA GELMI

MD, PHD CANDIDATE AT LEIDEN UNIVERSITY MEDICAL CENTER,

LEIDEN, THE NETHERLANDS

QUIZ TIME!



RETINA

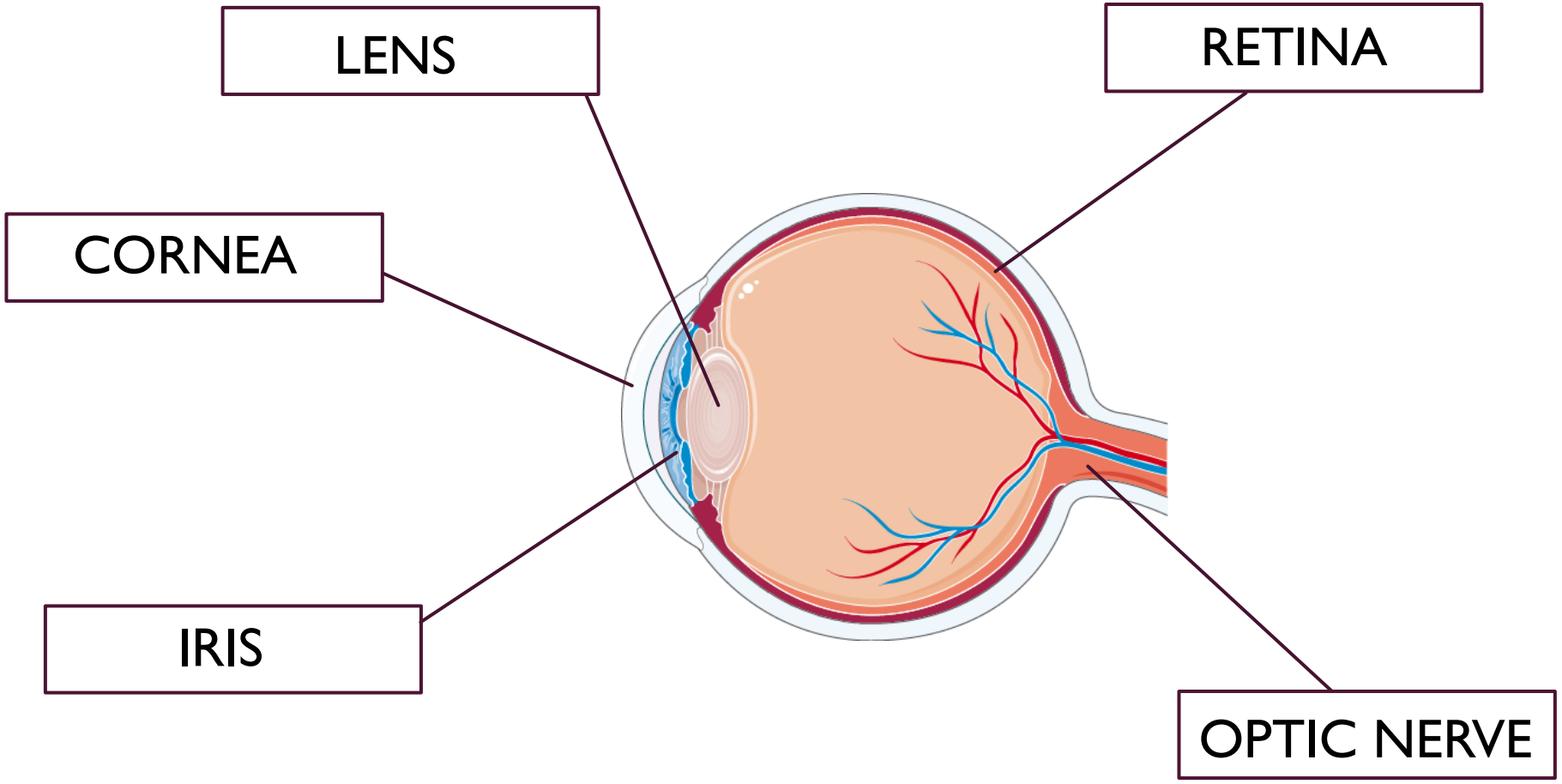
IRIS

CORNEA

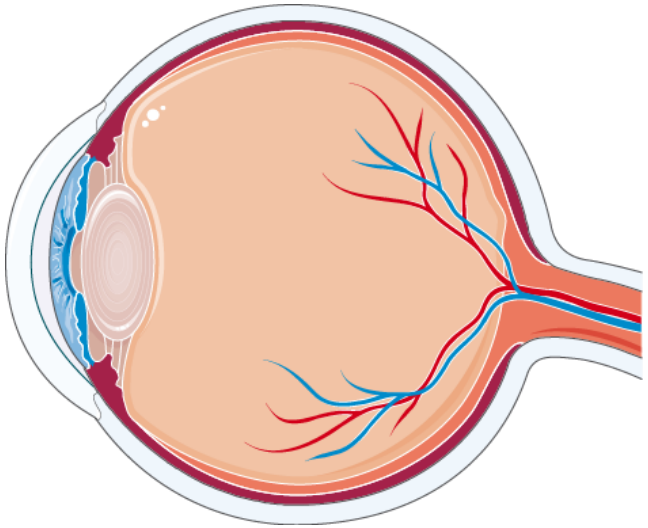
LENS

OPTIC NERVE

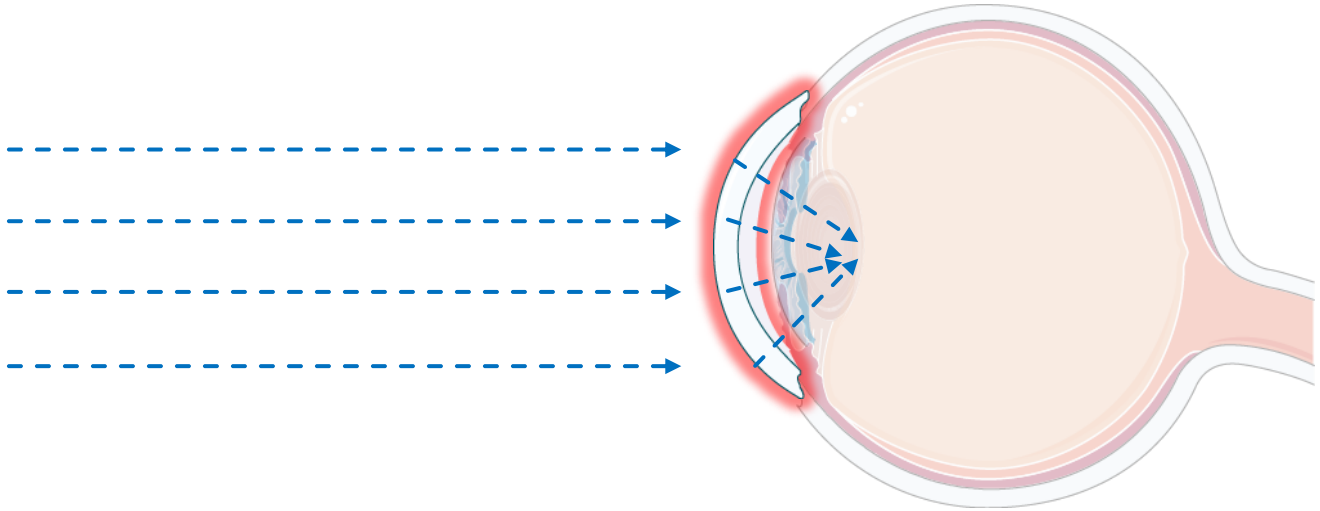
QUIZ TIME!



HOW DOES THE EYE WORK?



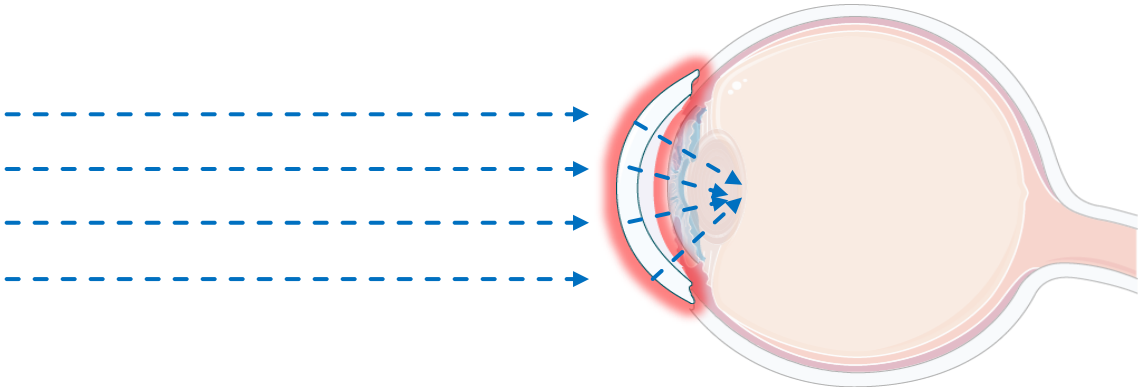
CORNEA

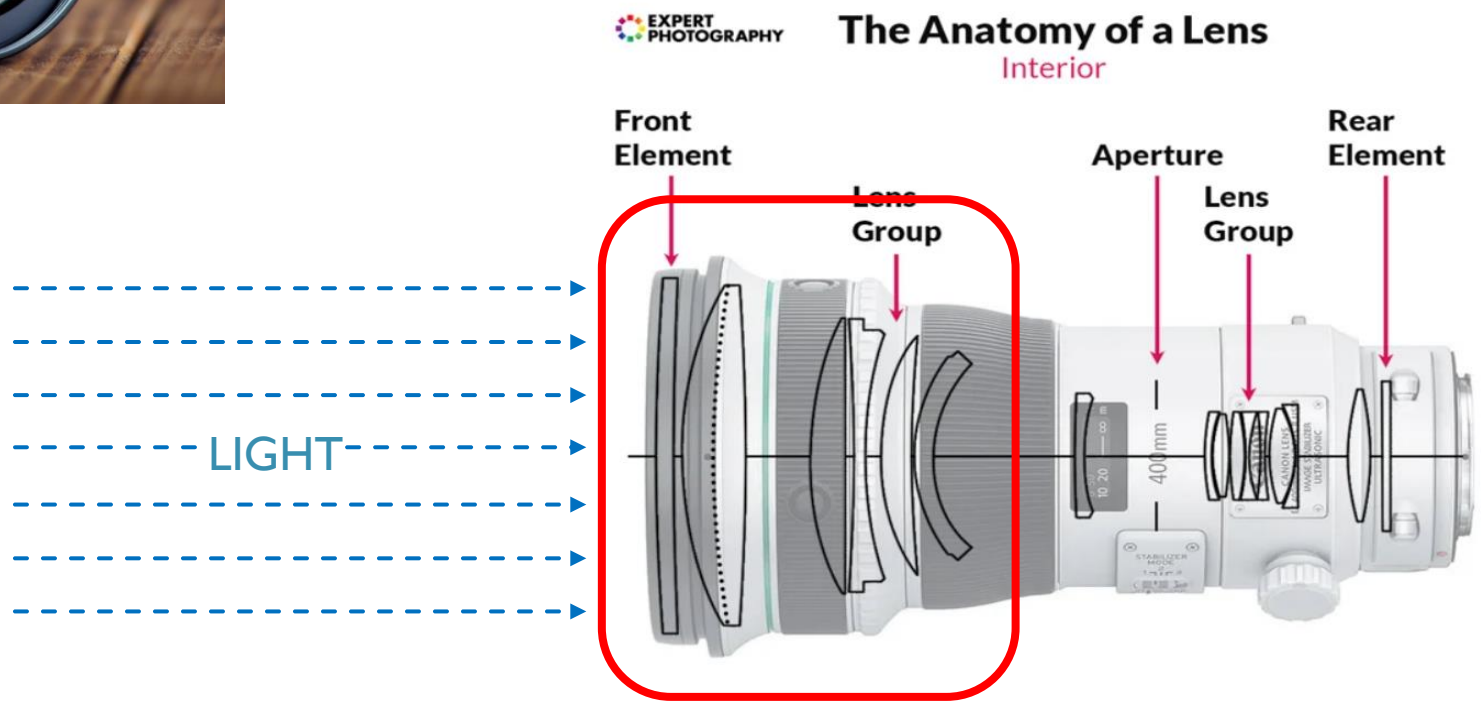


FUNCTIONS:

1. Physical barrier vs exterior
2. Transparent → allows light to pass through
3. Refracts / bends light → focuses light

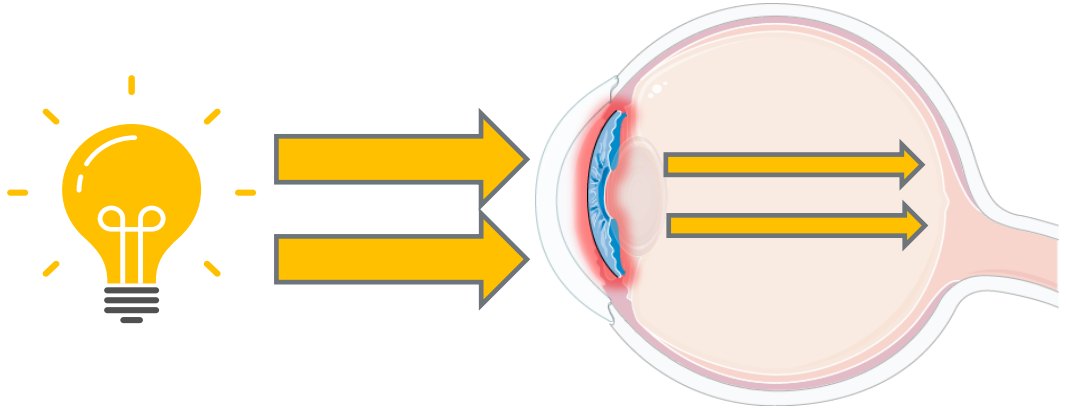
The cornea acts like the anterior lens of a camera





https://expertphotography.com/camera-lenses-guide/

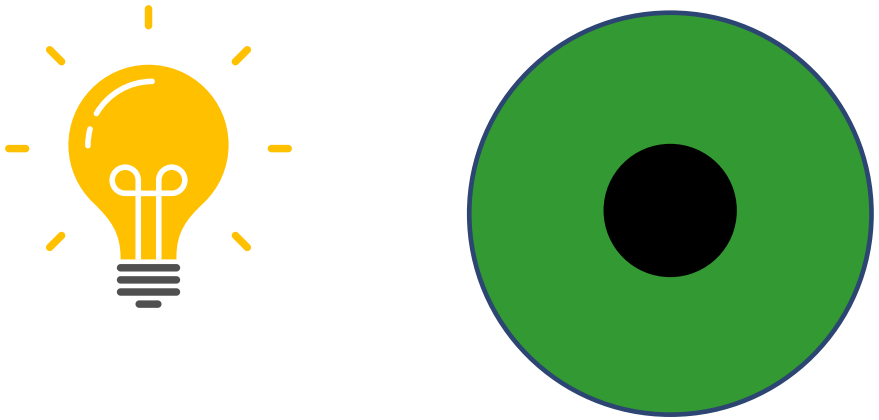
IRIS



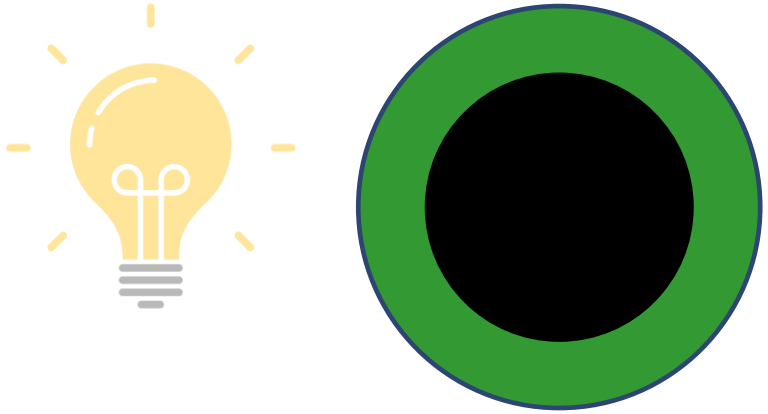
FUNCTION:

1. Eye colour
2. Controls the amount of light that enters the eye

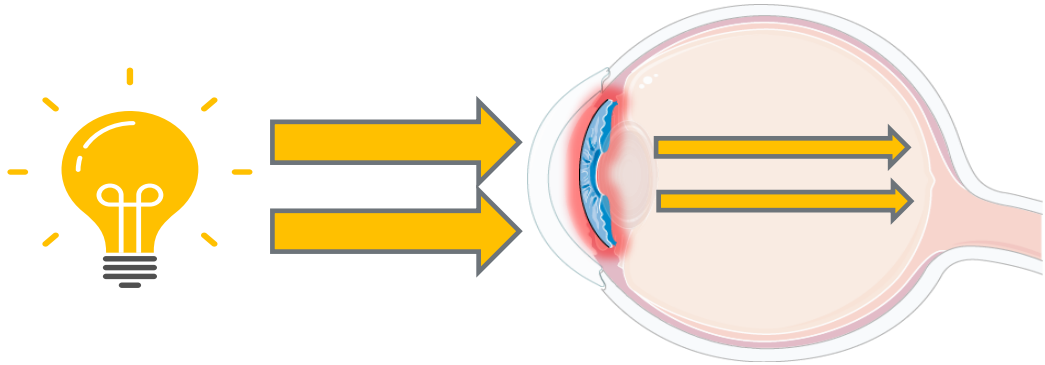
STRONG LIGHT



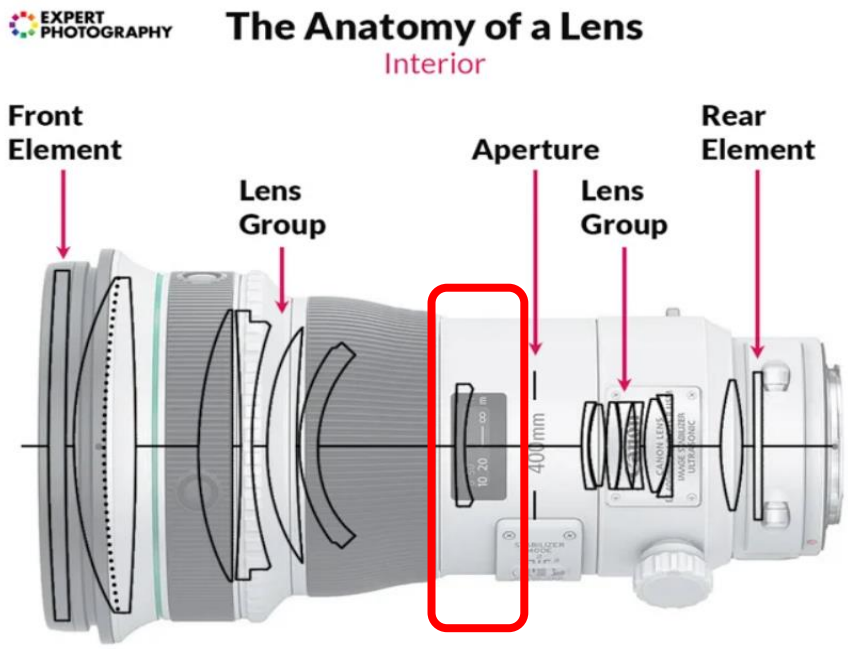
DIM LIGHT



The iris acts like the aperture / shutter of a camera

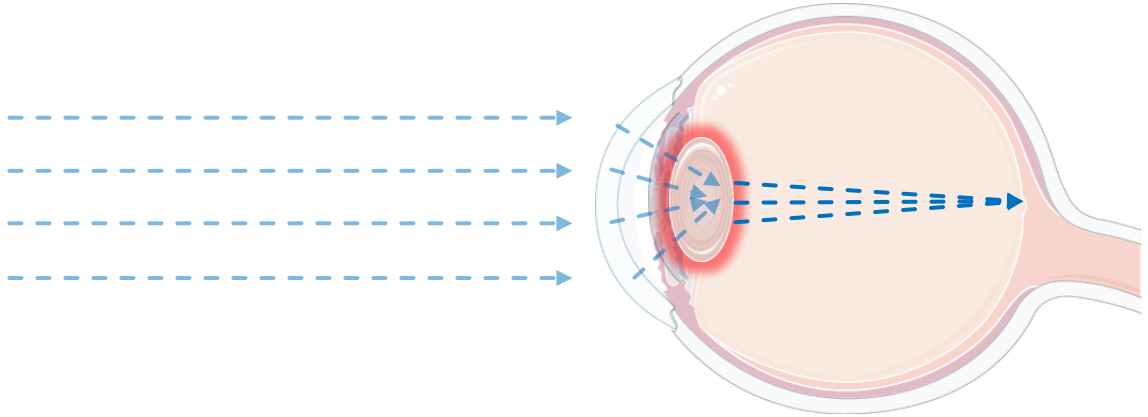


LIGHT



https://expertphotography.com/camera-lenses-guide/

LENS



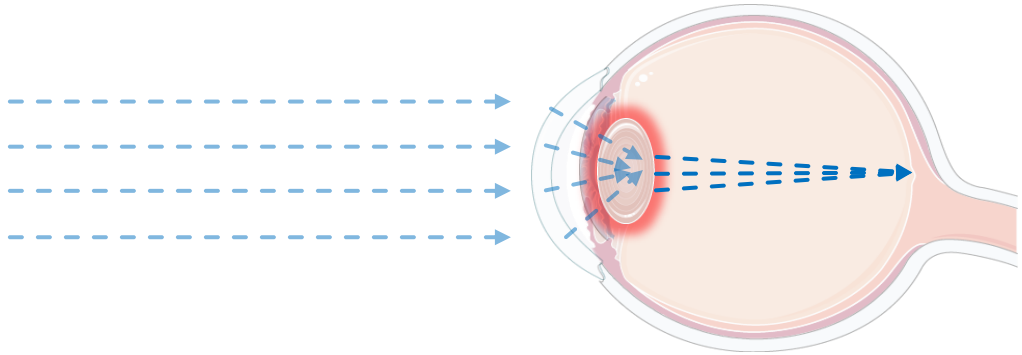
FUNCTION:

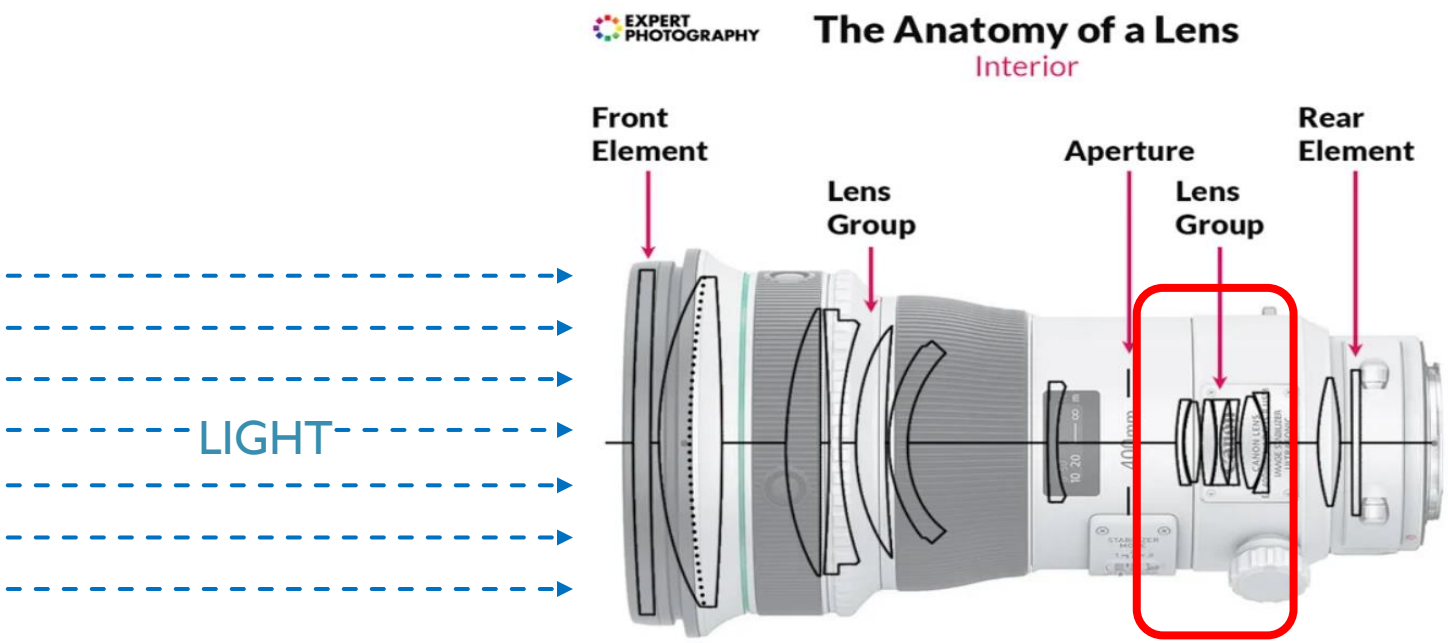
1. Changes shape and thickness to focus light rays
2. Transparent → allows light to pass through

DISTANT OBJECT

NEAR OBJECT

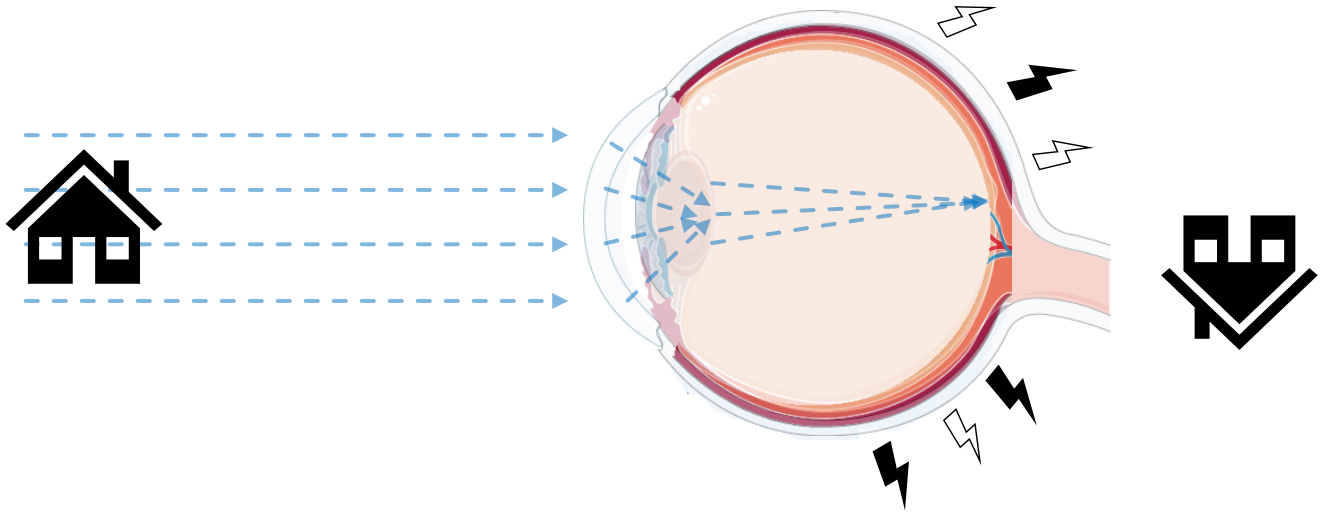
The lens acts like the lens of a camera





https://expertphotography.com/camera-lenses-guide/

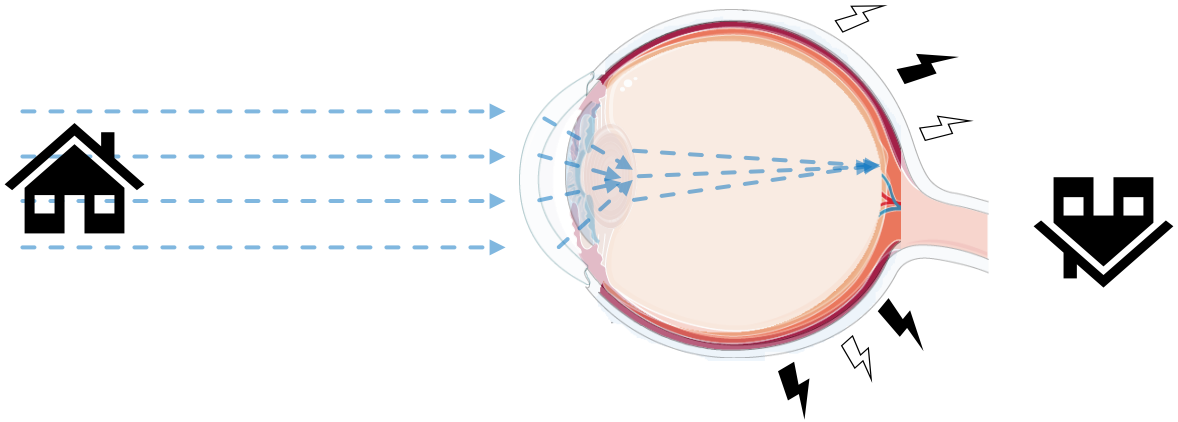
RETINA

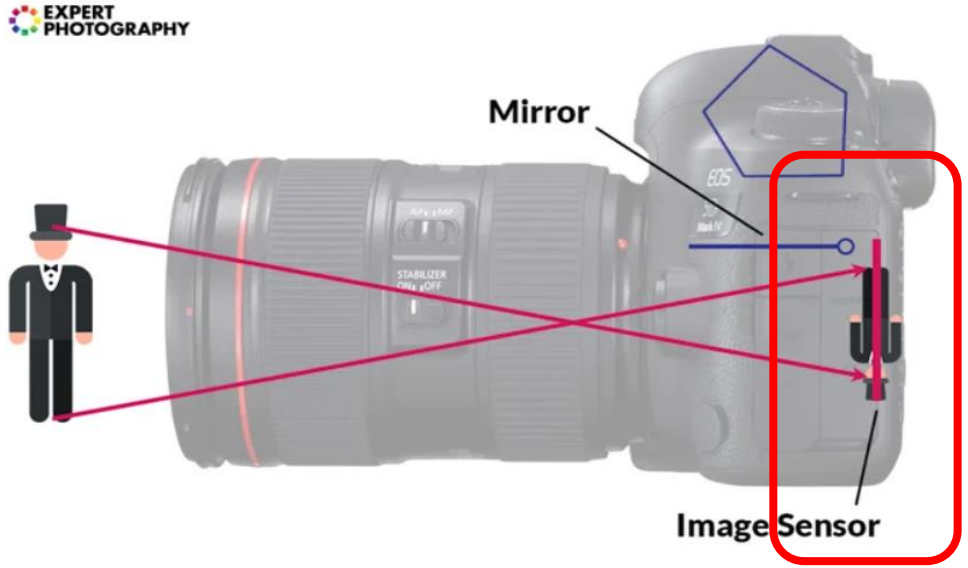


FUNCTION:

1. Converts light into electrical signals
2. It creates an upside-down image

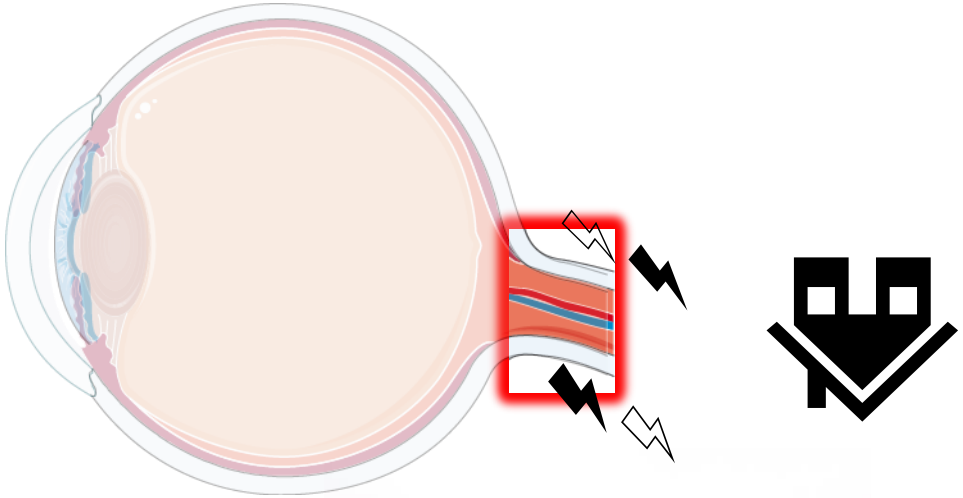
The retina acts like the film / image sensor of a camera

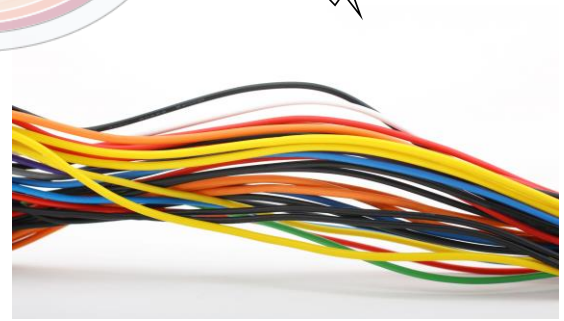




https://expertphotography.com/camera-lenses-guide/

OPTIC NERVE





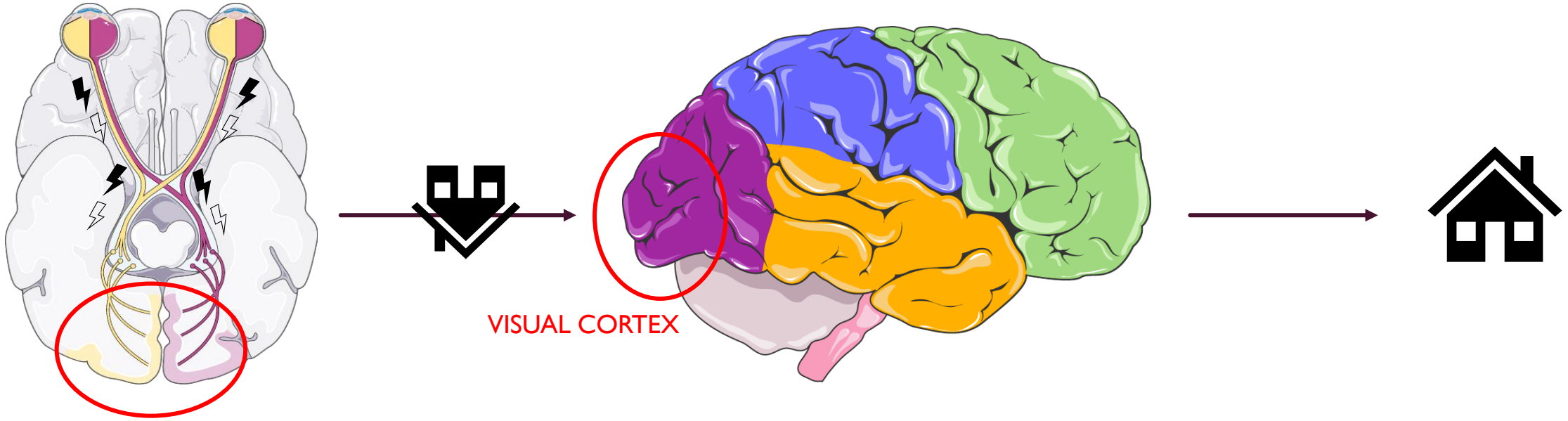
FUNCTION:

1. Collects visual information from all the parts of the retina
2. Acts like a wire to transport electrical information

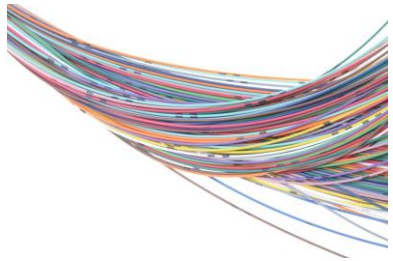
BRAIN / VISUAL CORTEX

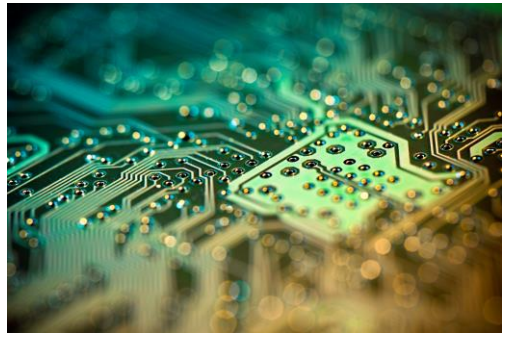
FUNCTION:

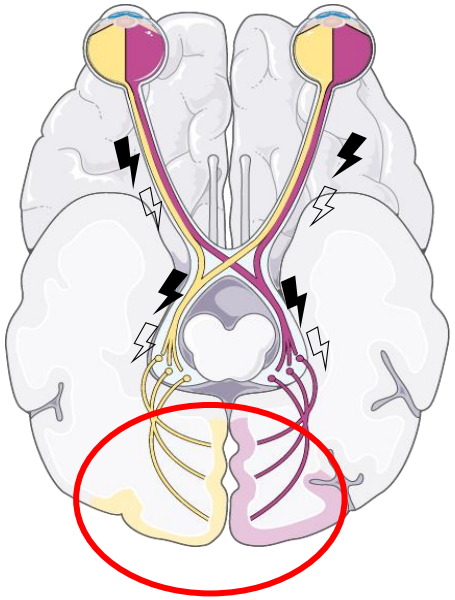
1. Receives the electrical information from the optic nerve and optic tract
2. Processes the electrical information → creates the image the right way up

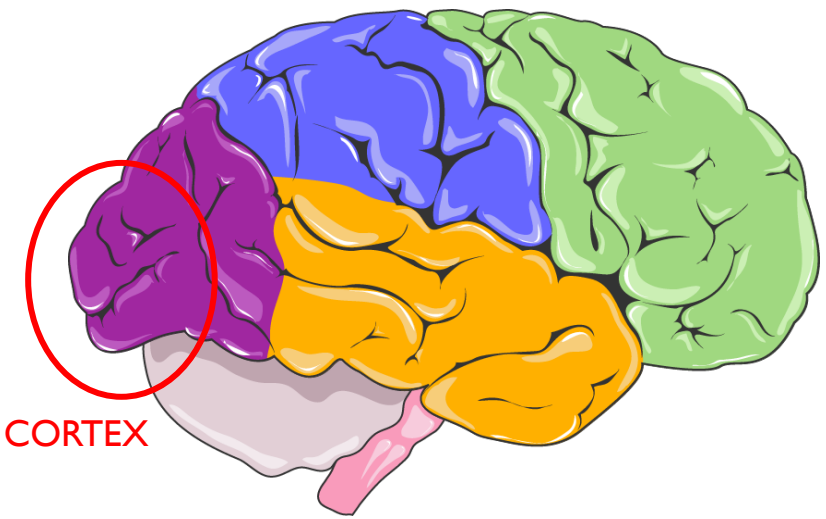


The brain acts like the a processor





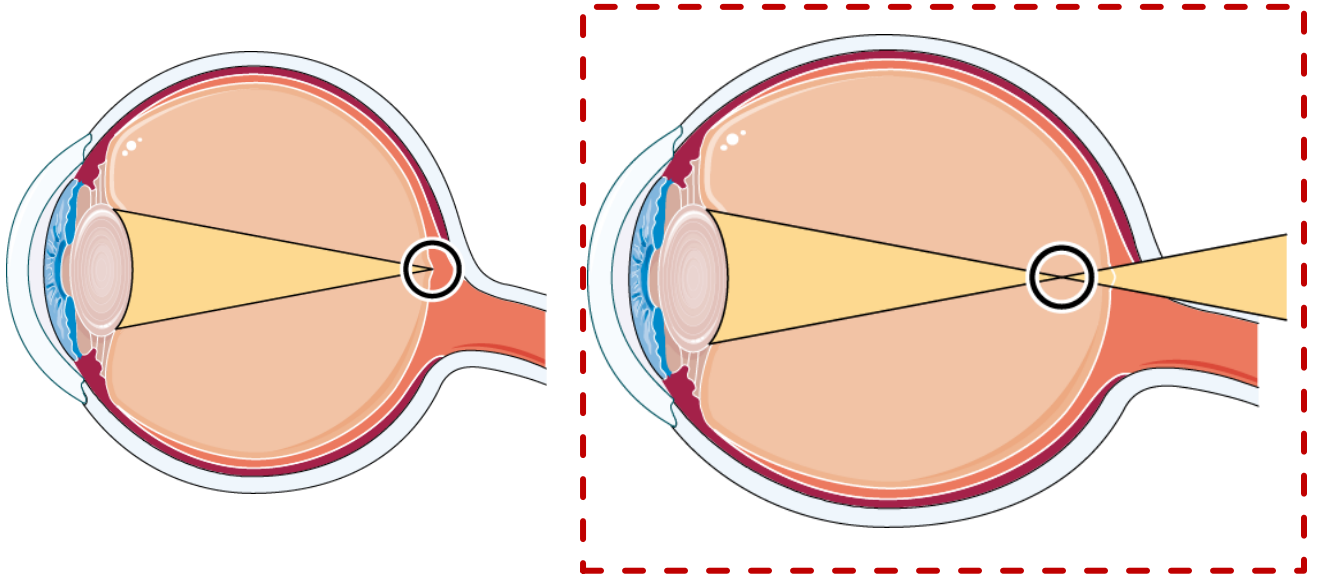




VISUAL CORTEX

MYOPIA / SHORT-SIGHTEDNESS

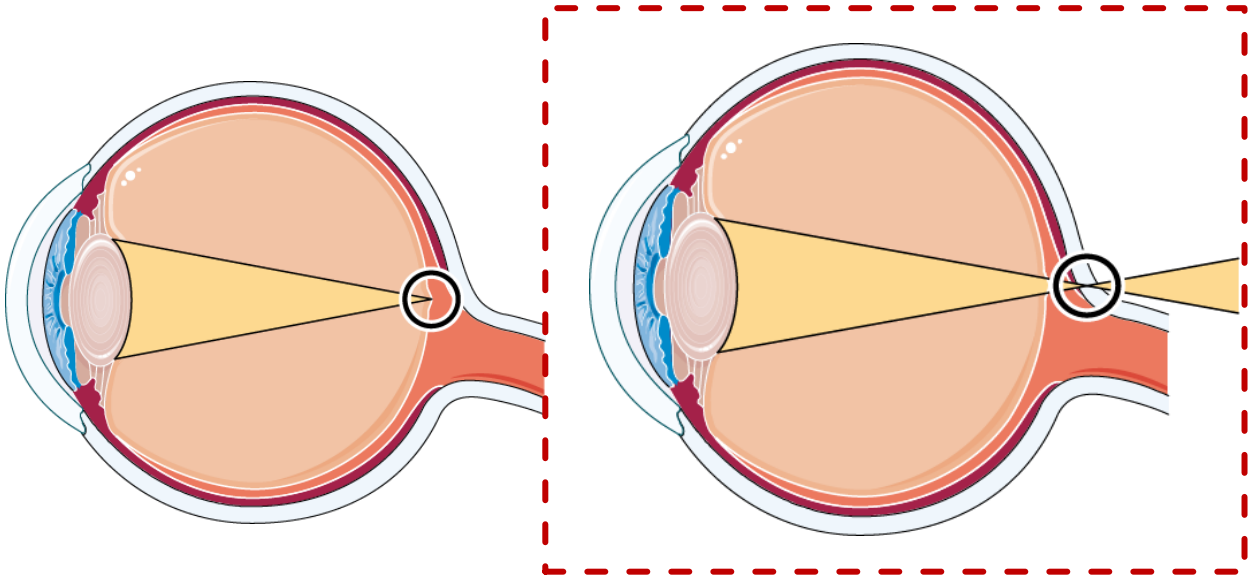
The eyeball is LONGER than normal → focus in front of the retina → *DISTANT objects are blurry*

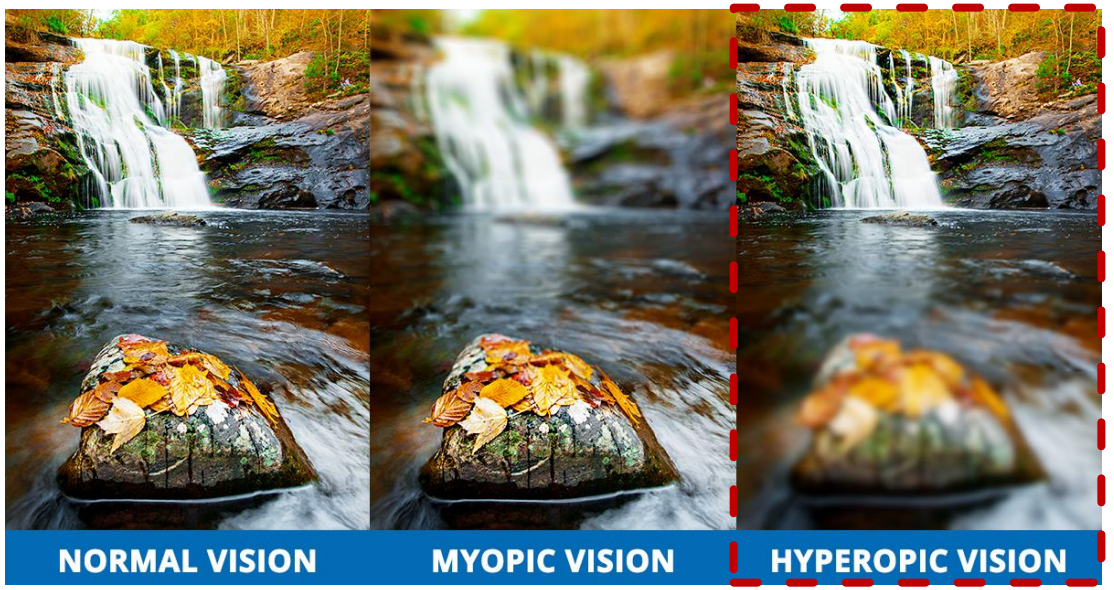


https://www.asiapacificeyecentre.com.sg/myopia/

HYPEROPIA / FAR-SIGHTEDNESS

The eyeball is SHORTER than normal → focus behind the retina → *NEAR objects are blurry*

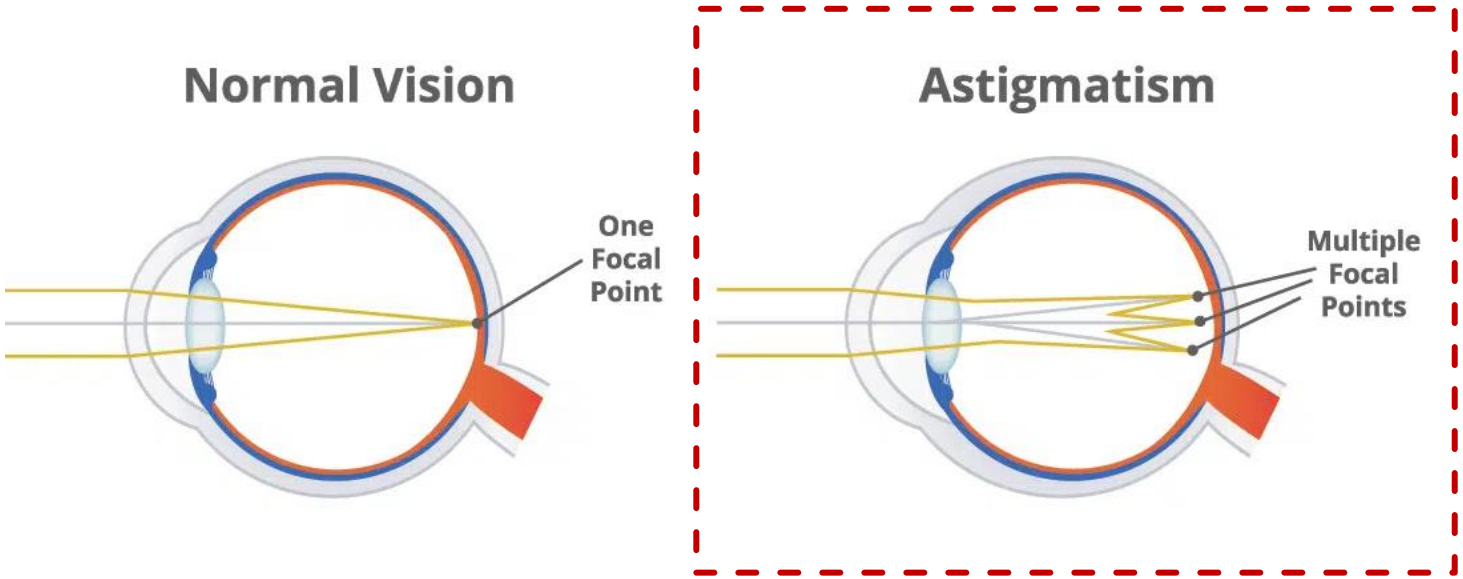




https://www.asiapacificeyecentre.com.sg/myopia/

ASTIGMATISM

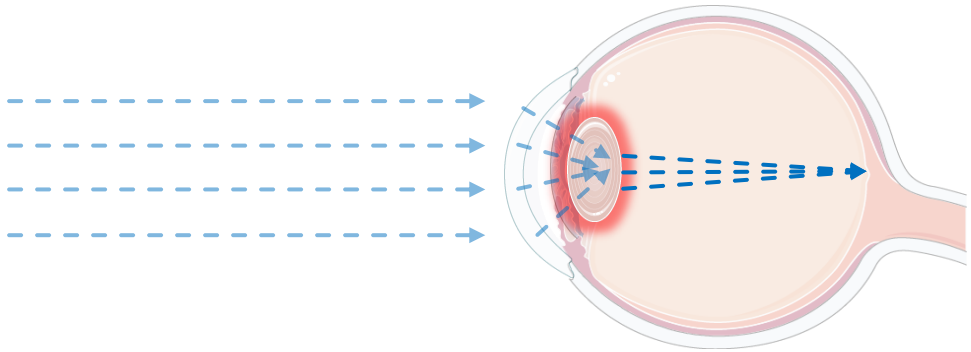
The cornea has a different CURVATURE → multiple focal points→ *image is blurry, glare/halos around lights*



https://www.jameswoodeyecare.co.uk/astigmatism/

CATARACT

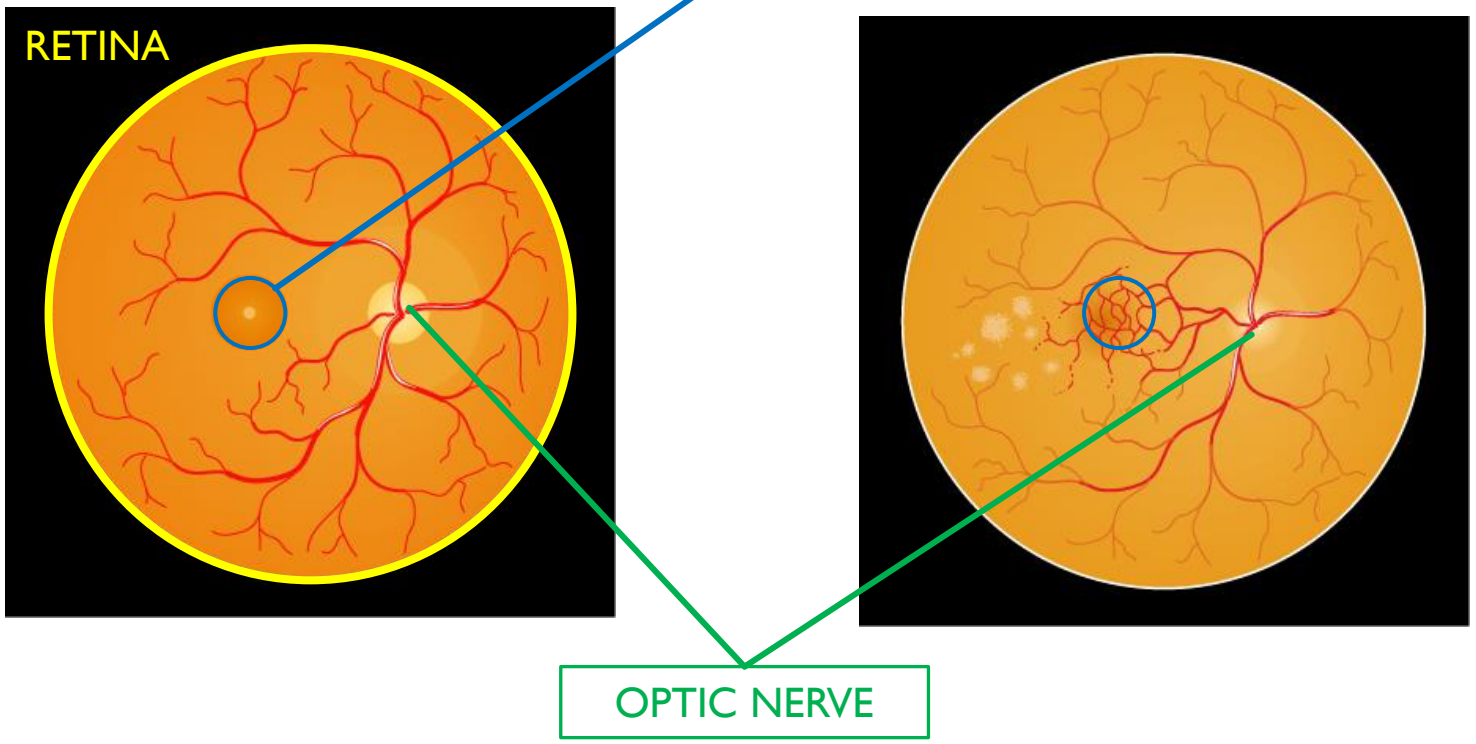
- The lens becomes CLOUDY →
  - *No clear image*
  - *Halos around lights*
- Usually age-related



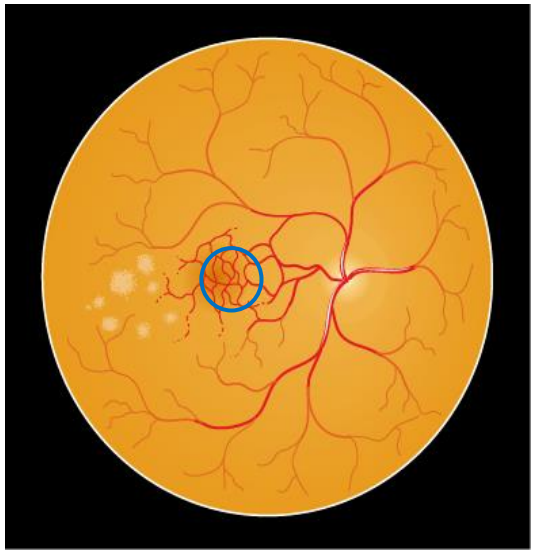
https://eyenj.com/cataracts-glen-rock/

MACULAR DEGENERATION

MACULA:
- Most important part of the retina
- Highest density of cone photoreceptors
- Part of the retina for well-defined, central colour vision



Accumulation of EXTRA MATERIAL in the macula
- ➢ loss of CENTRAL VISION
- ➢ DISTORTED LINES

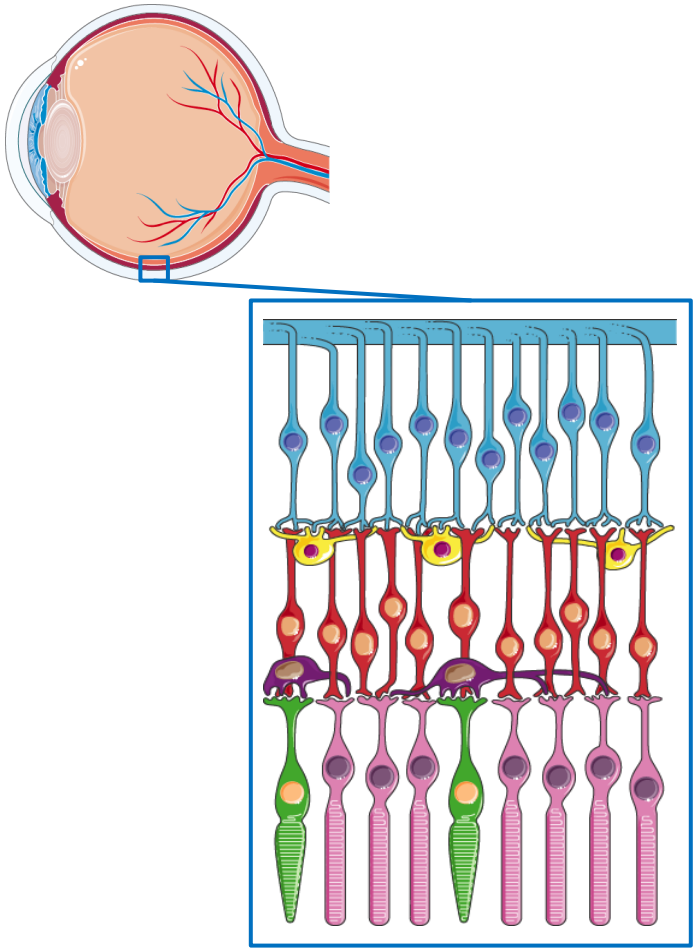


MACULAR DEGENERATION:

- Accumulation of EXTRA MATERIAL in the macula
  - loss of CENTRAL VISION
  - DISTORTED LINES
- Age-related

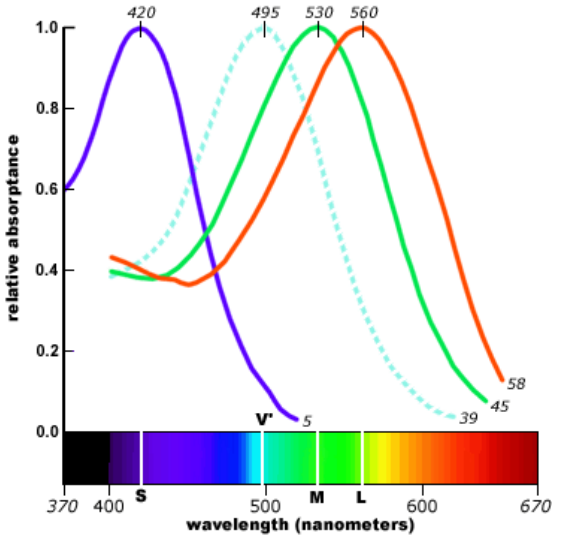
https://www.drkaiafas.gr/eye-diseases/amd

PHOTORECEPTORS



ROD photoceptors:

- Night-time vision (scotopic)
- No colour vision

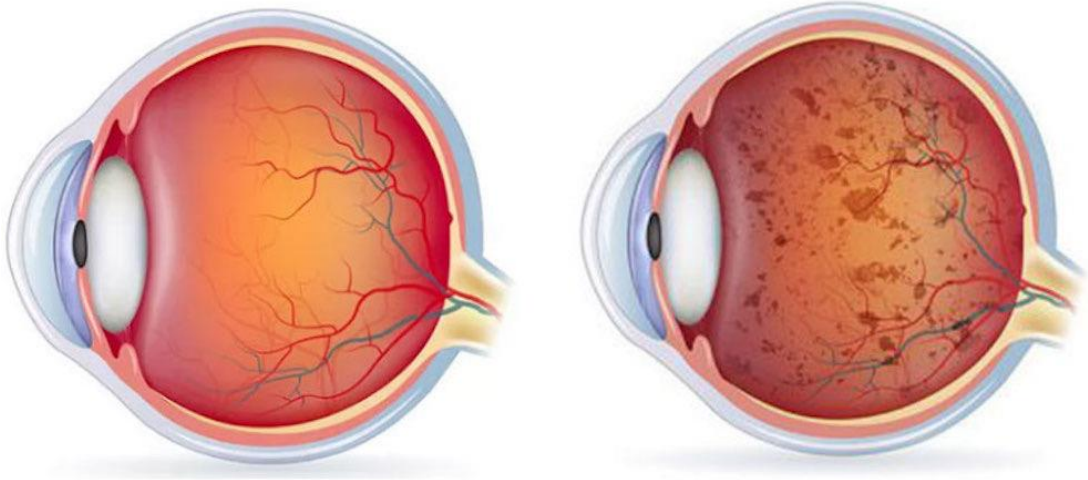


http://www.handprint.com/HP/WCL/color1.html

CONE photoceptors:

- Day-time vision (mesopic)
- Colour vision: sensitive to different wavelengths → different colours:
  - L: long wavelength (~560-570 nm) → red
  - M: medium wavelength (~530-540 nm) → green
  - S: short wavelength (~420-440 nm) → blue

ROD PHOTORECEPTORS: RETINITIS PIGMENTOSA



Damage / death of ROD photoreceptors:

- Night blindness
- Tunnel vision

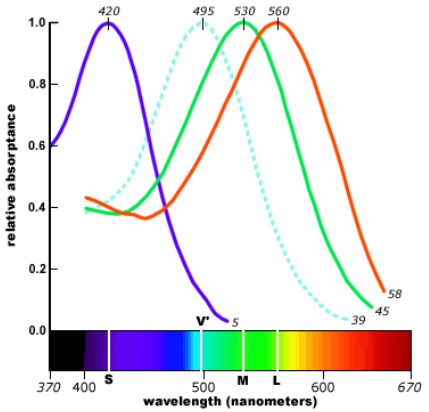
NORMAL VISION

TUNNEL VISION

https://www.srsb.org.uk/Retinitis-Pigmentosa/

CONE PHOTOREPECTOR: COLOUR VISION DEFICIENCIES

Cone	Colour	Missing cone	Mutated cone	Axis	Visual acuity
L-M-S	All colours	Complete achromatopsia	Incomplete achromatopsia	All colours	Low
L	Red	Protanopia	Protanomay	Red-green	Normal
M	Green	Deuteranopia	Deuteranomaly	Red-green	Normal
S	Blue	Tritanopia	Tritanomaly	Blue-yellow	Normal



http://www.handprint.com/HP/WCL/color1.html

Cone	Colour	Missing cone	Mutated cone	Axis	Visual acuity
L-M-S	All colours	Complete achromatopsia	Incomplete achromatopsia	All colours	Low

Tondo Doni, Michelangelo,
Galleria degli Uffizi, Firenze

Achromatopsia

Cone	Colour	Missing cone	Mutated cone	Axis	Visual acuity
L	Red	Protanopia	Protanomaly	Red-green	Normal

Tondo Doni, Michelangelo,
Galleria degli Uffizi, Firenze

Protanopia
L (red) cone dysfunction

Cone	Colour	Missing cone	Mutated cone	Axis	Visual acuity
M	Green	Deuteranopia	Deuteranomaly	Red-green	Normal

Tondo Doni, Michelangelo,
Galleria degli Uffizi, Firenze

Deuteranopia
M (green) cone dysfunction

Cone	Colour	Missing cone	Mutated cone	Axis	Visual acuity
S	Blue	Tritanopia	Tritanomaly	Blue-yellow	Normal

Tondo Doni, Michelangelo,
Galleria degli Uffizi, Firenze

Tritanopia
S (blue) cone dysfunction

ACTIVITY: EXAMPLE OF A CLINICAL TRIAL

1. Pick a topic
2. How would you approach this problem?
3. What steps do we need to take?
4. What people do we need?

Topics:

- Refractive errors:
  - New type of lens
  - World-wide distribution
- Cataract:
  - Compare two surgical instruments
  - Compare two antibiotic eye drops
- Macular degeneration
  - New type of visual aid
  - New type of therapy
- Retinitis pigmentosa:
  - New type of visual aid
  - New type of gene therapy

Genes

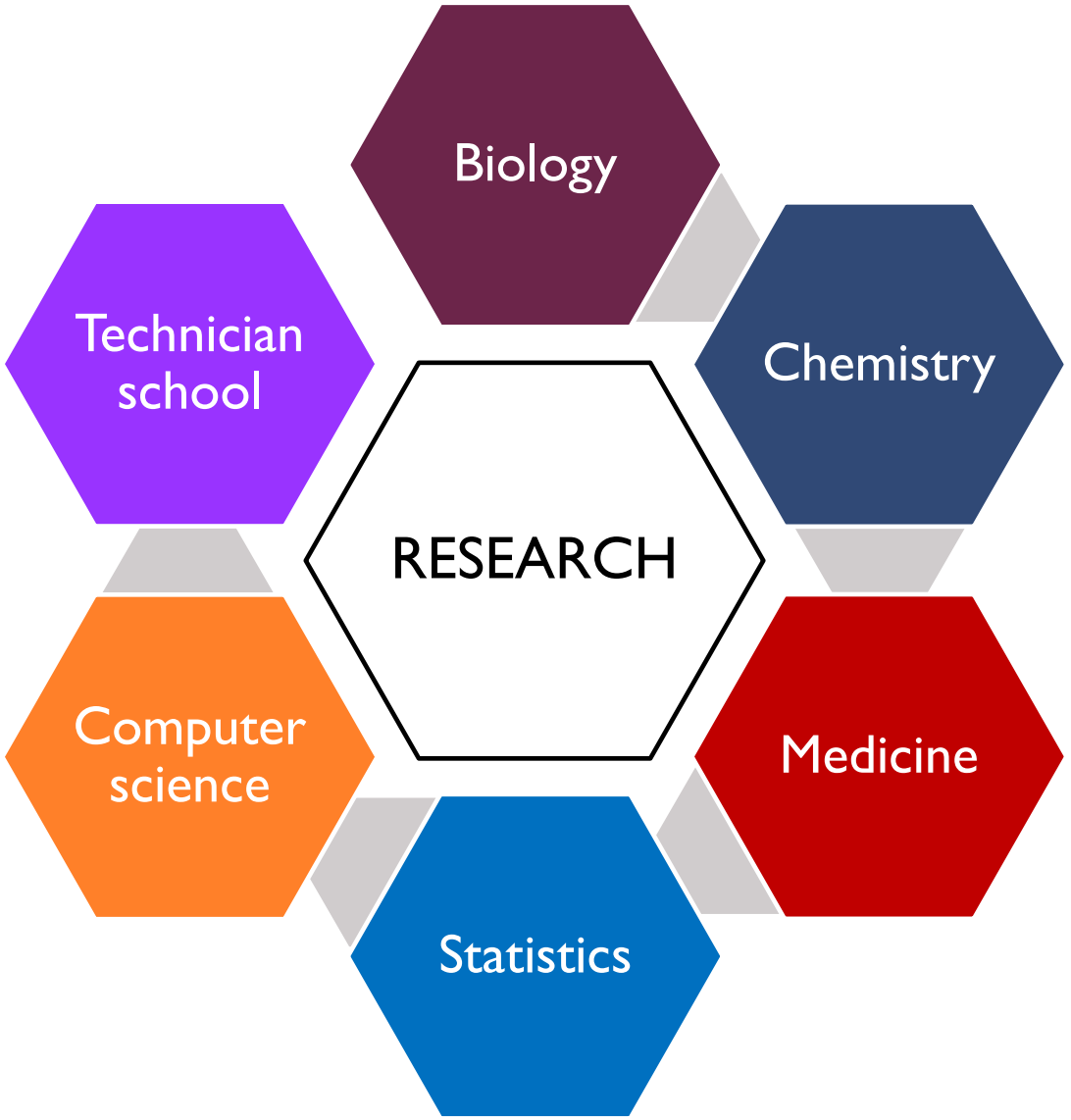
Cells

RESEARCH

Data

Animals

Humans


Biology
Technician school
Chemistry
RESEARCH
Computer science
Medicine
Statistics