Choices and Vision

Jeffrey Koziol M.D.

- How does the eye work?
- What is myopia?
- What is hyperopia?
- What is astigmatism?
- What is presbyopia?

How the eye works

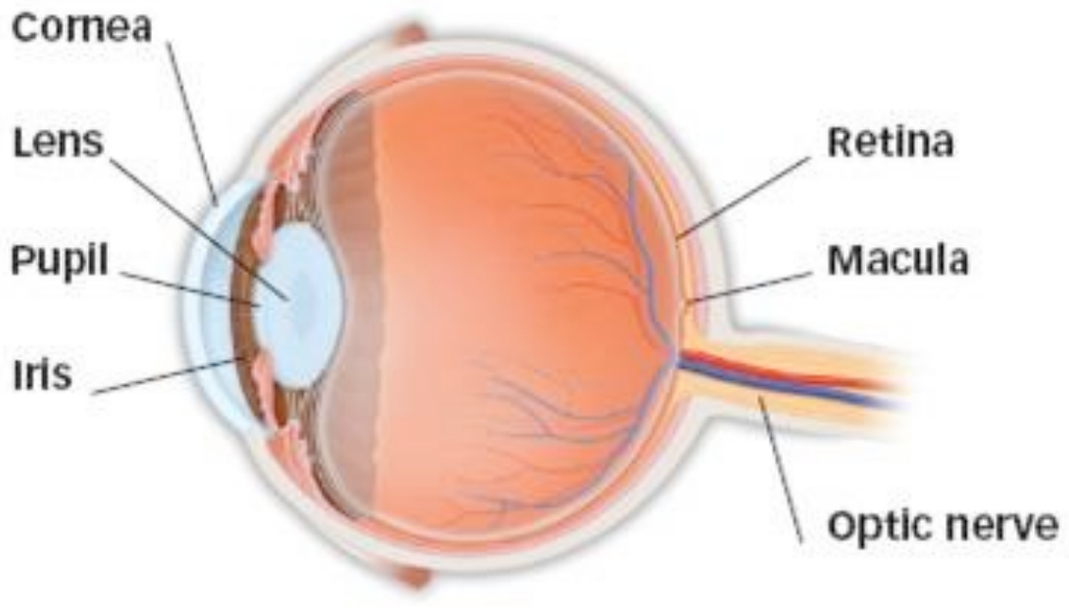
How the eye works

Light rays enter the eye through the clear cornea, pupil and lens.

These light rays are focused directly onto the retina, the light-sensitive tissue lining the back of the eye.

The retina converts light rays into impulses, sent through the optic nerve to your brain, where they are recognized as images.

70% of the eye's focusing power comes from the cornea and 30% from the lens.



Eye anatomy

Refractive errors

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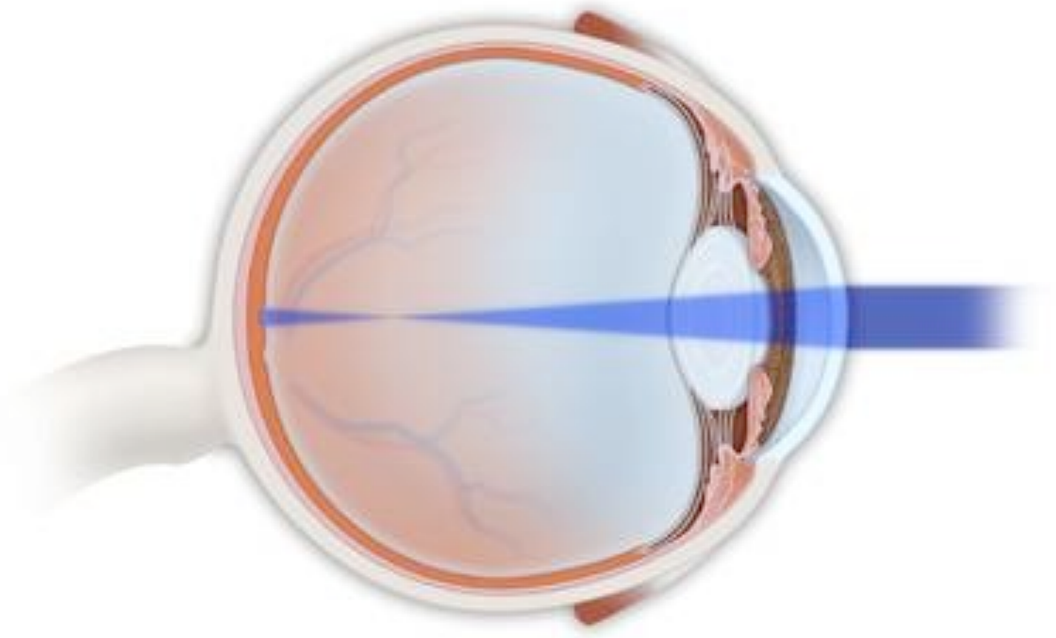

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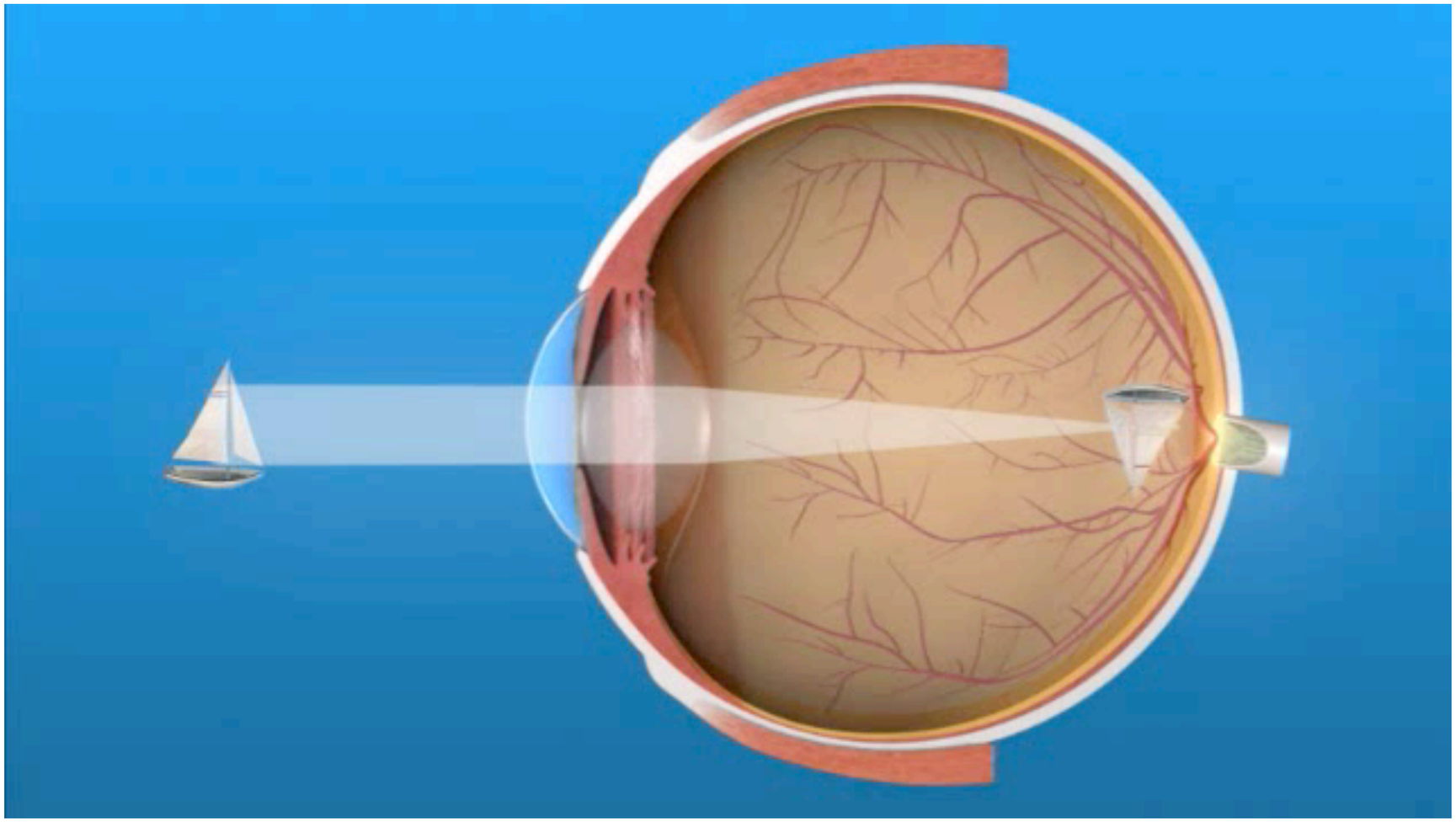

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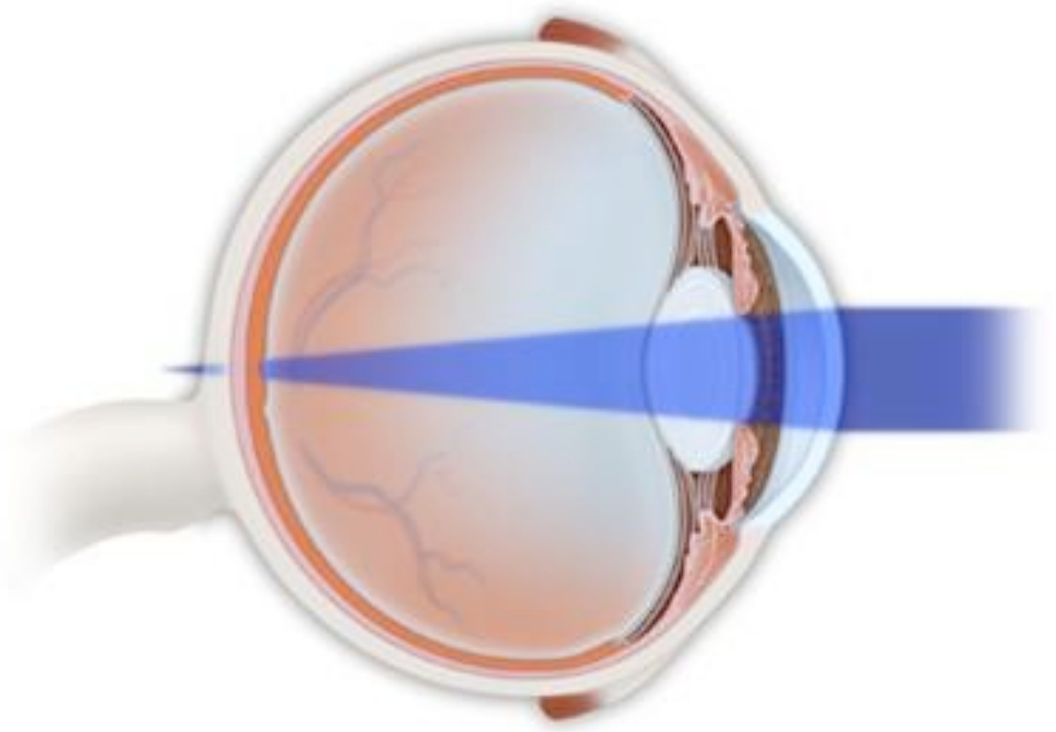

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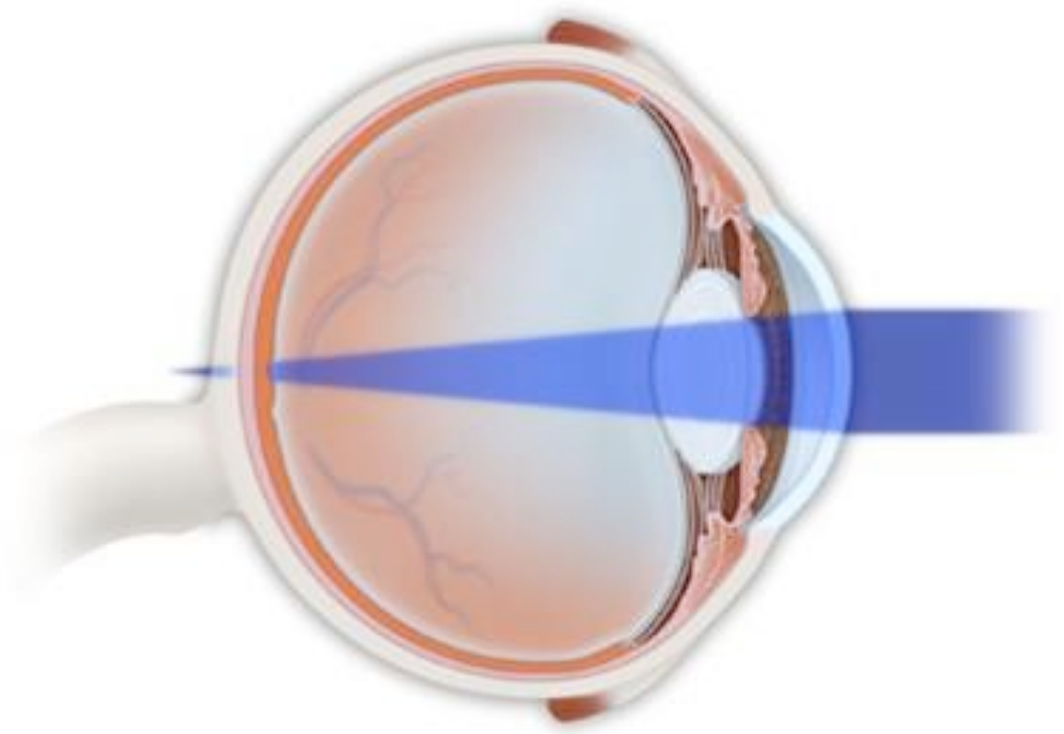

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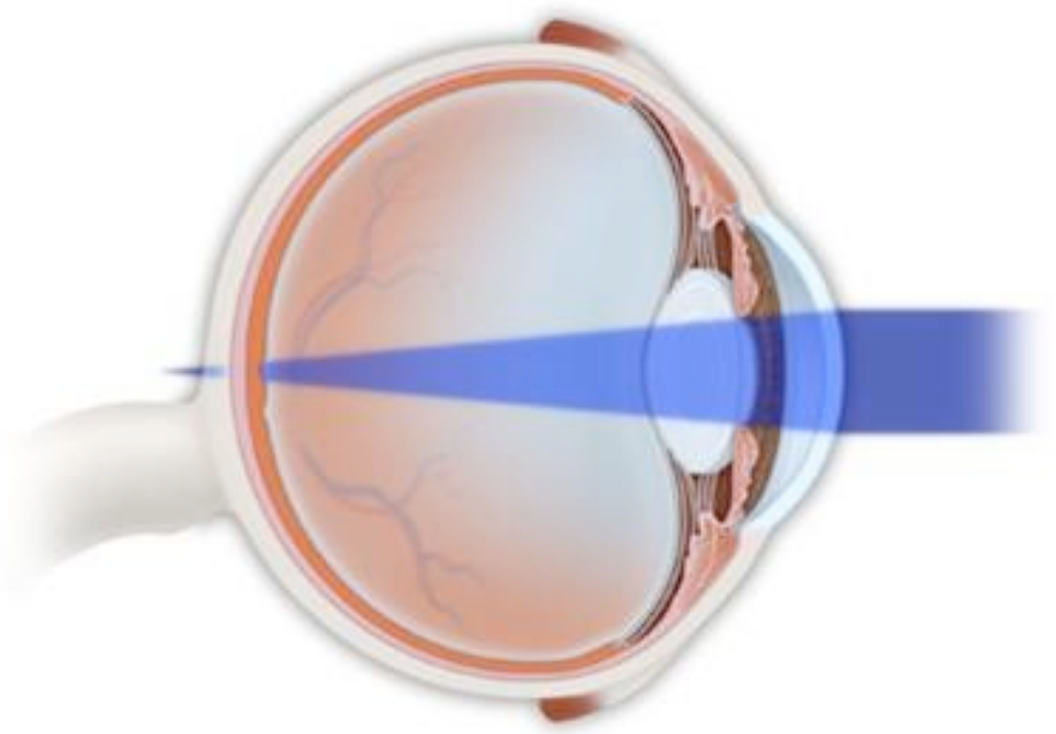

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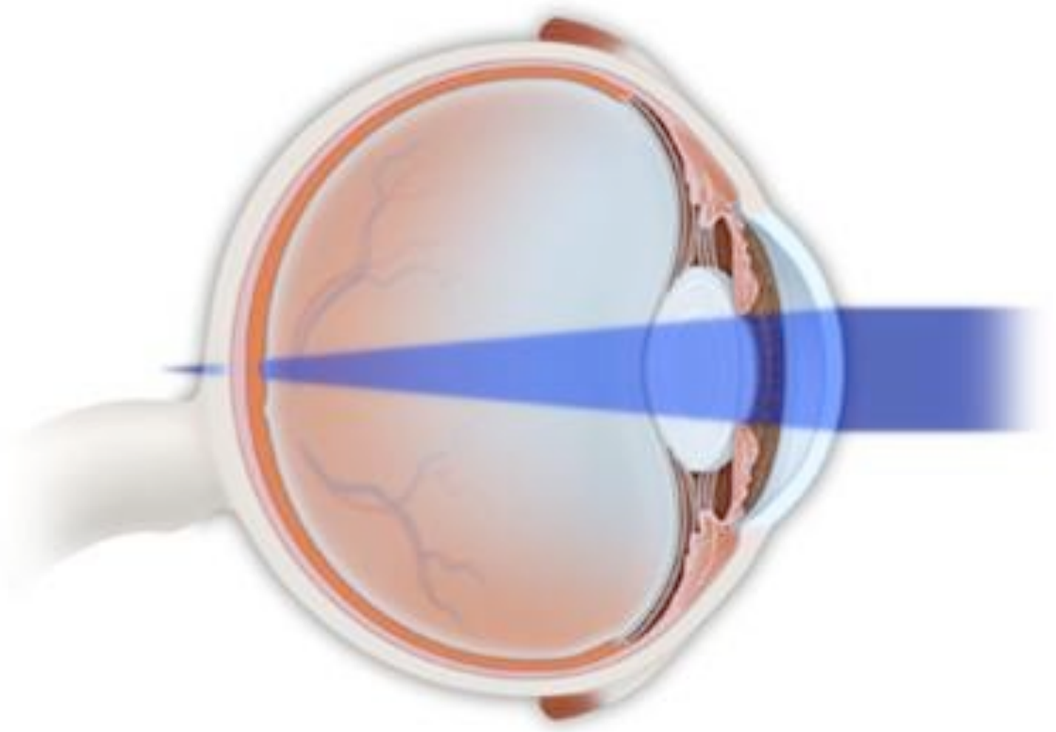

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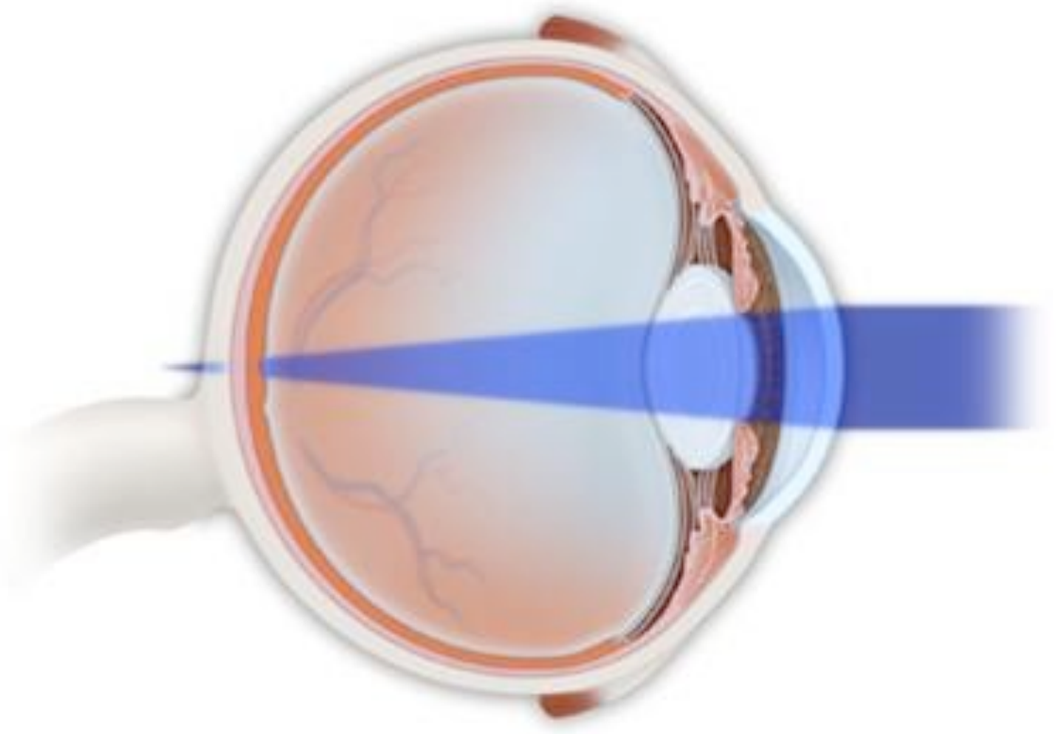

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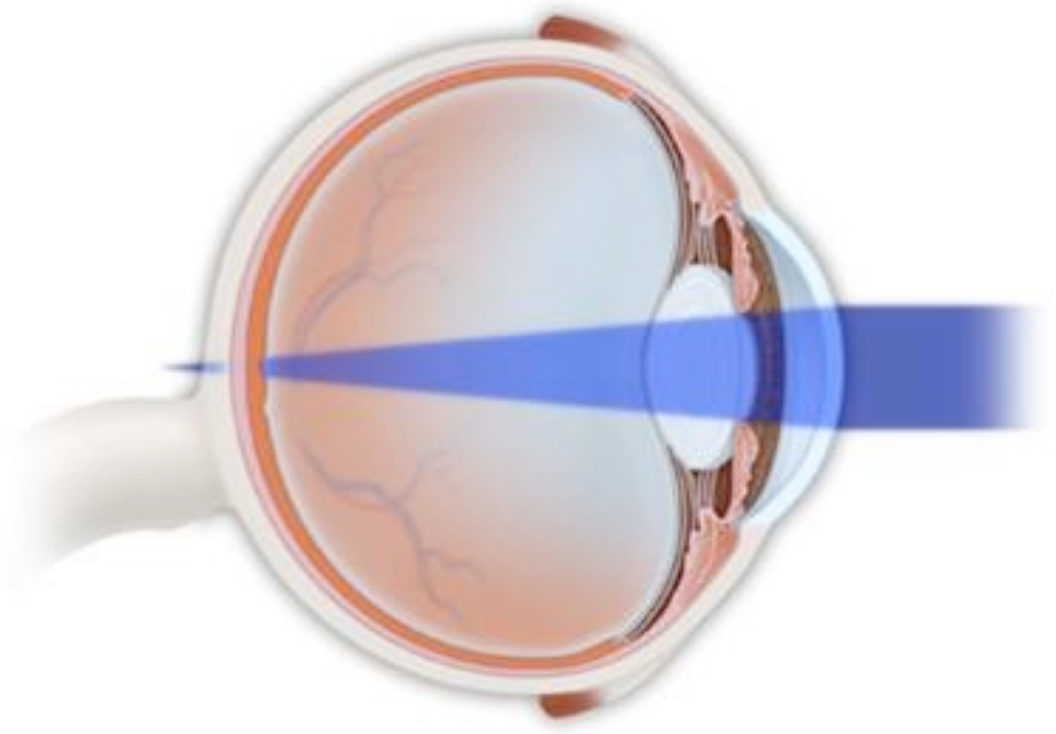

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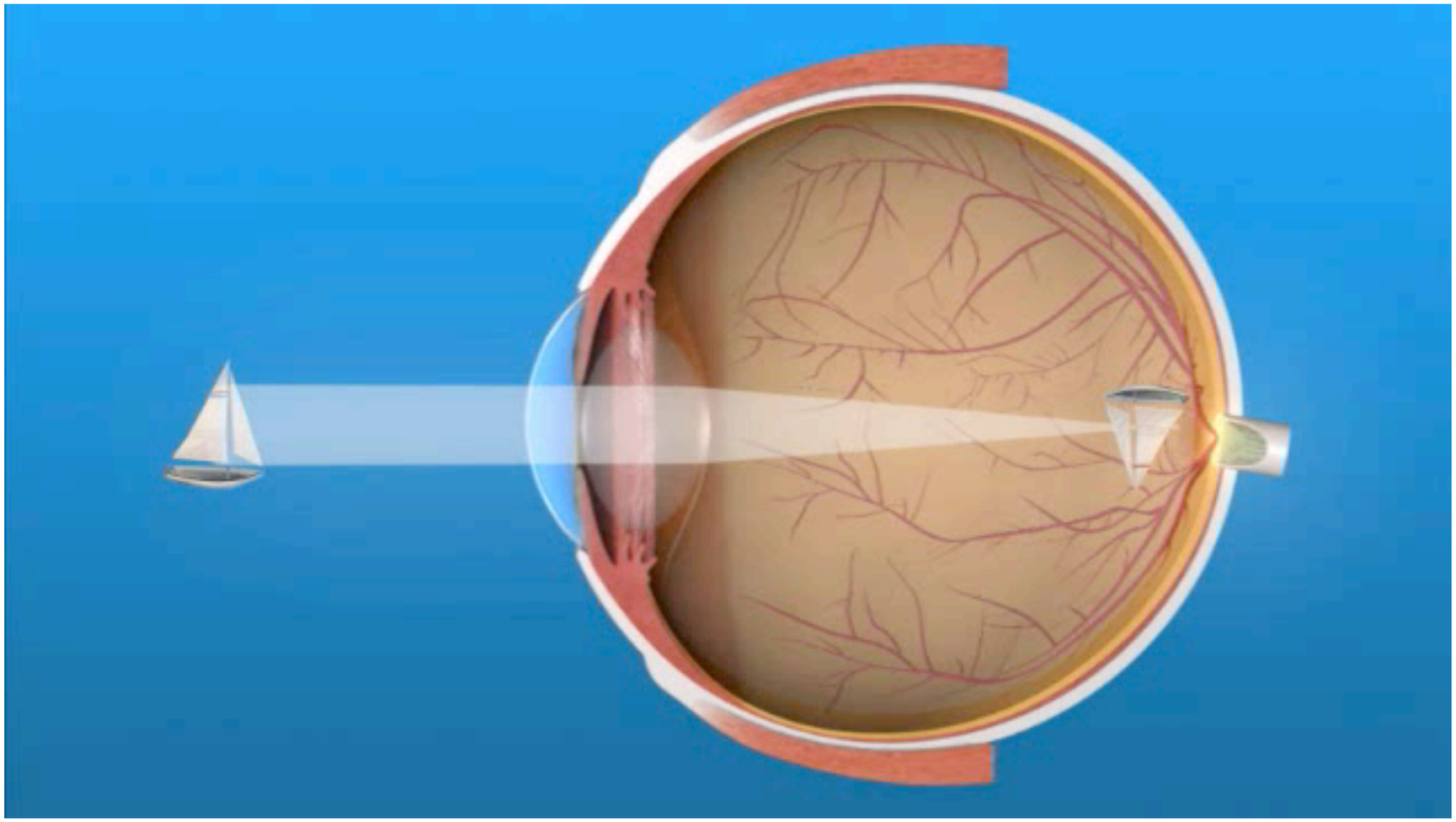

Refractive errors: hyperopia

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Astigmatism occurs when light passes

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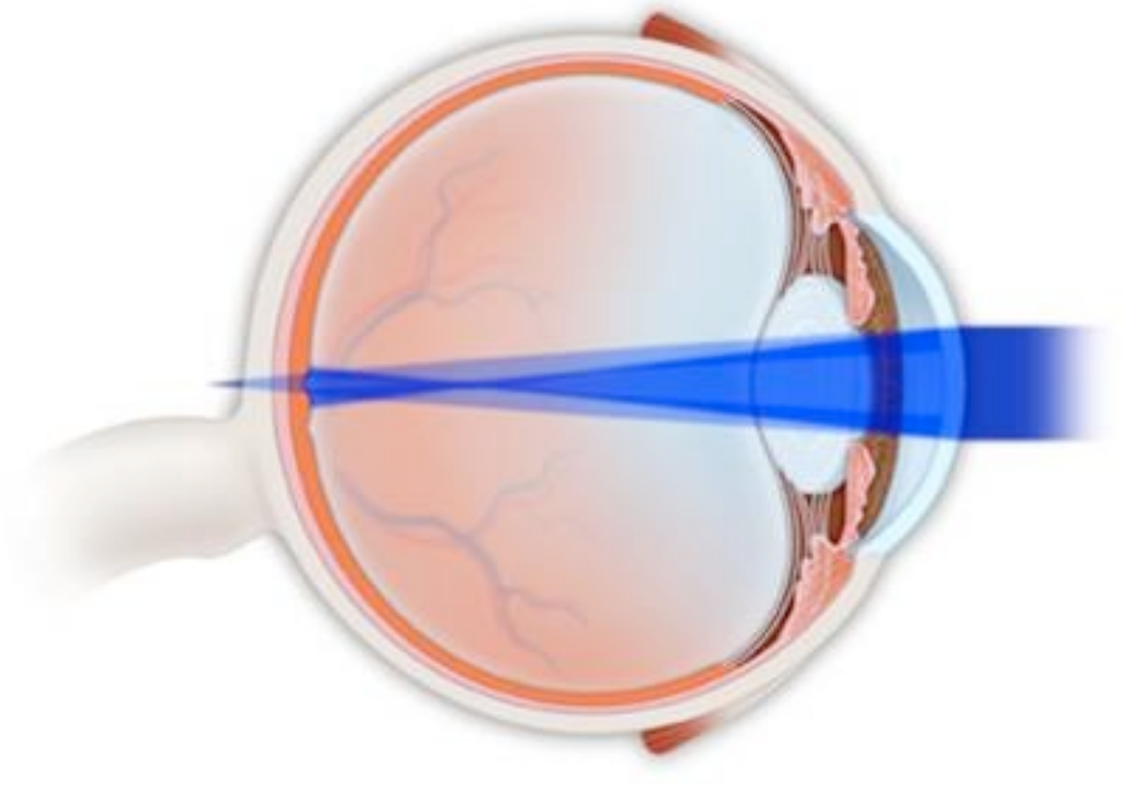

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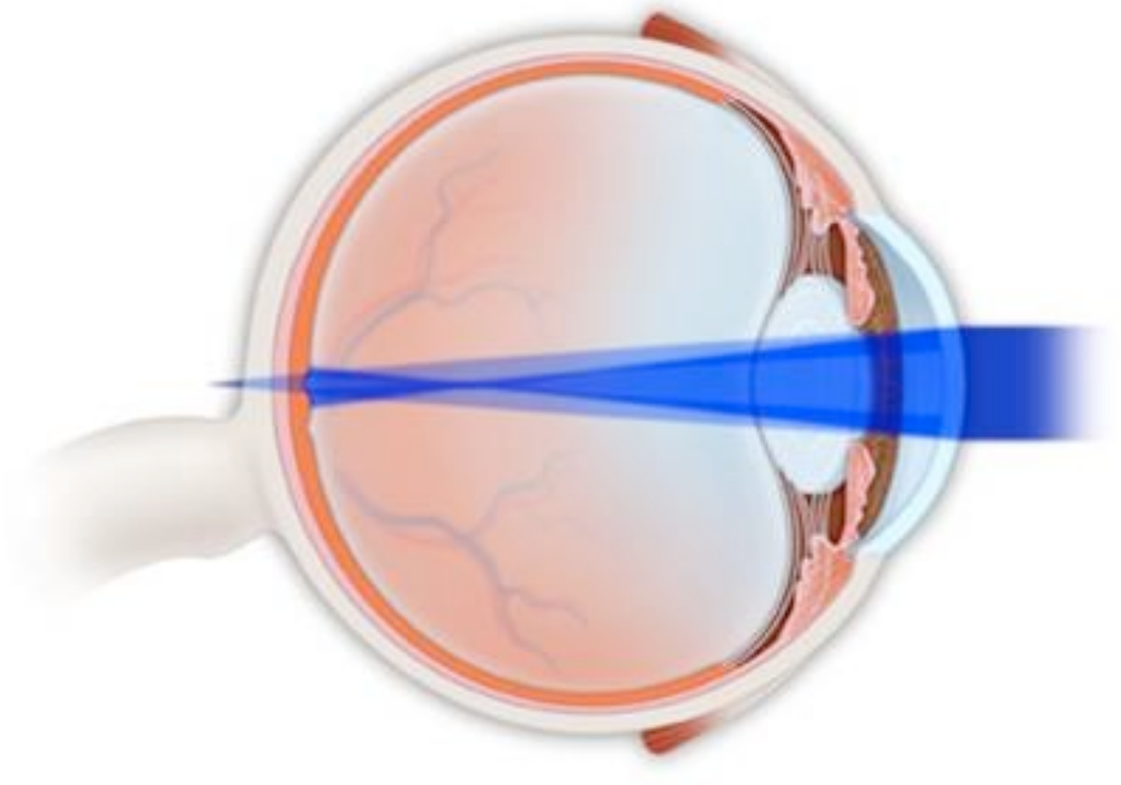
In astigmatism, the cornea is curved unevenly — shaped more like a football than a basketball.



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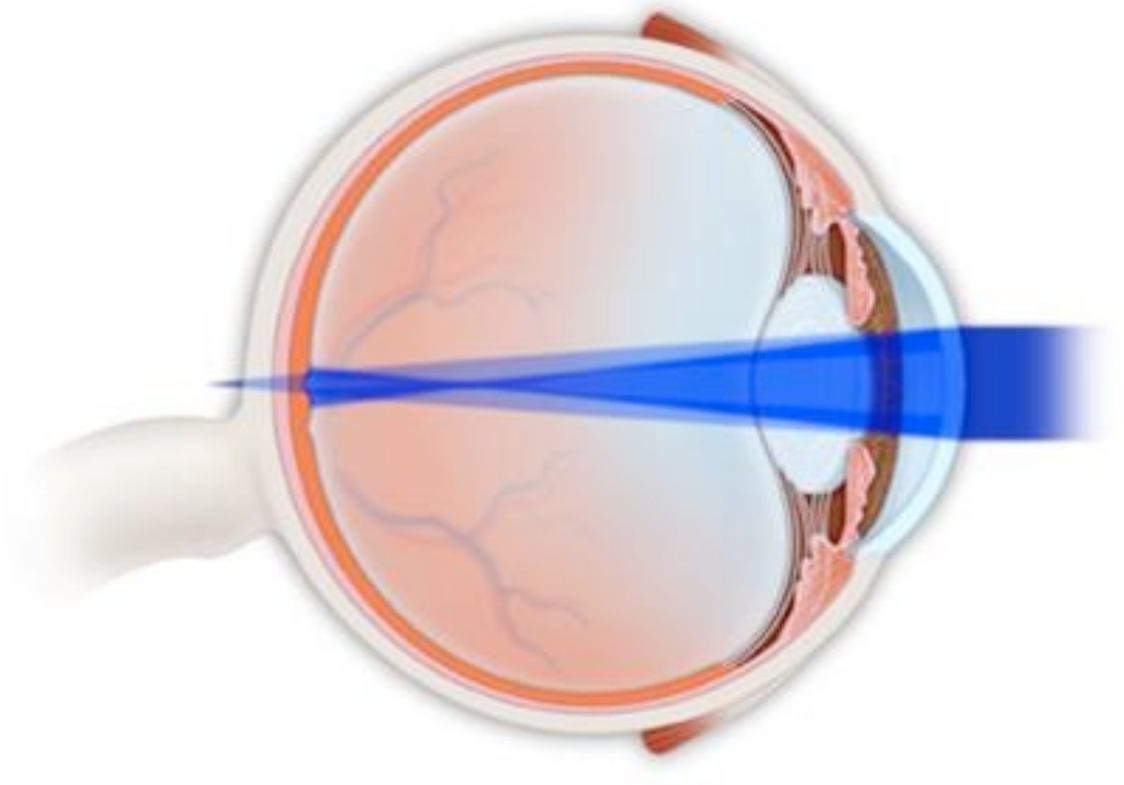

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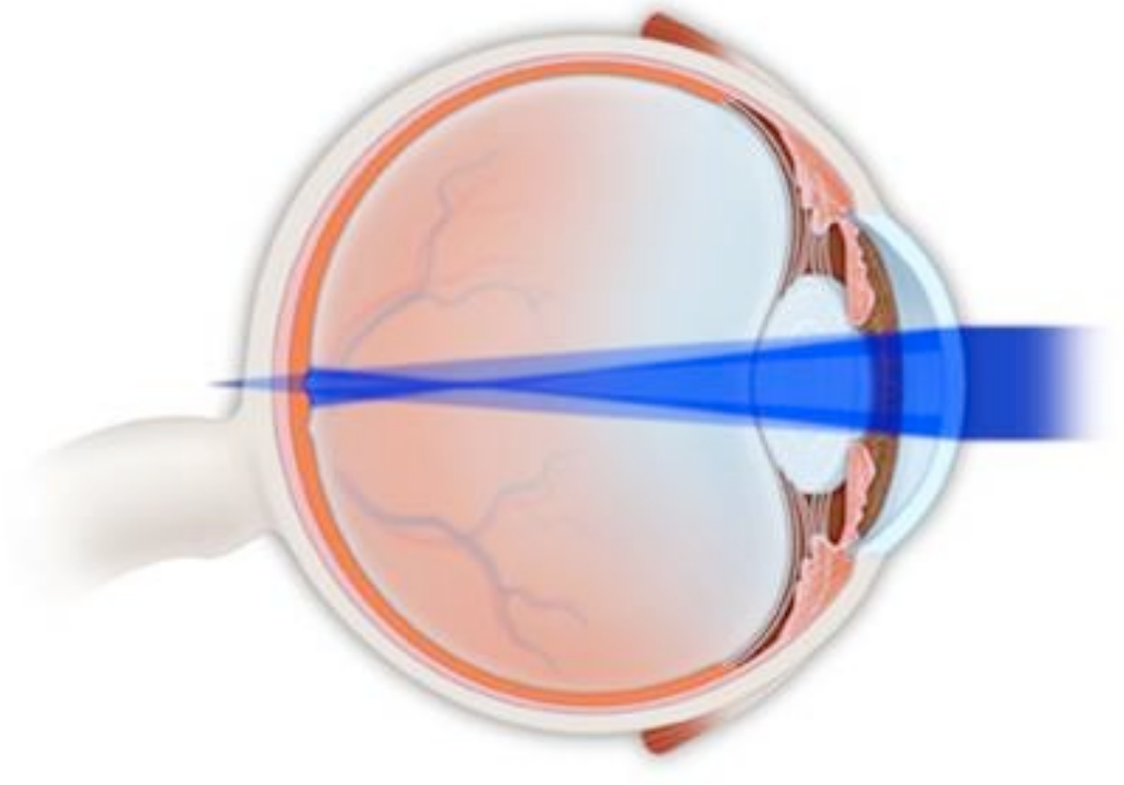

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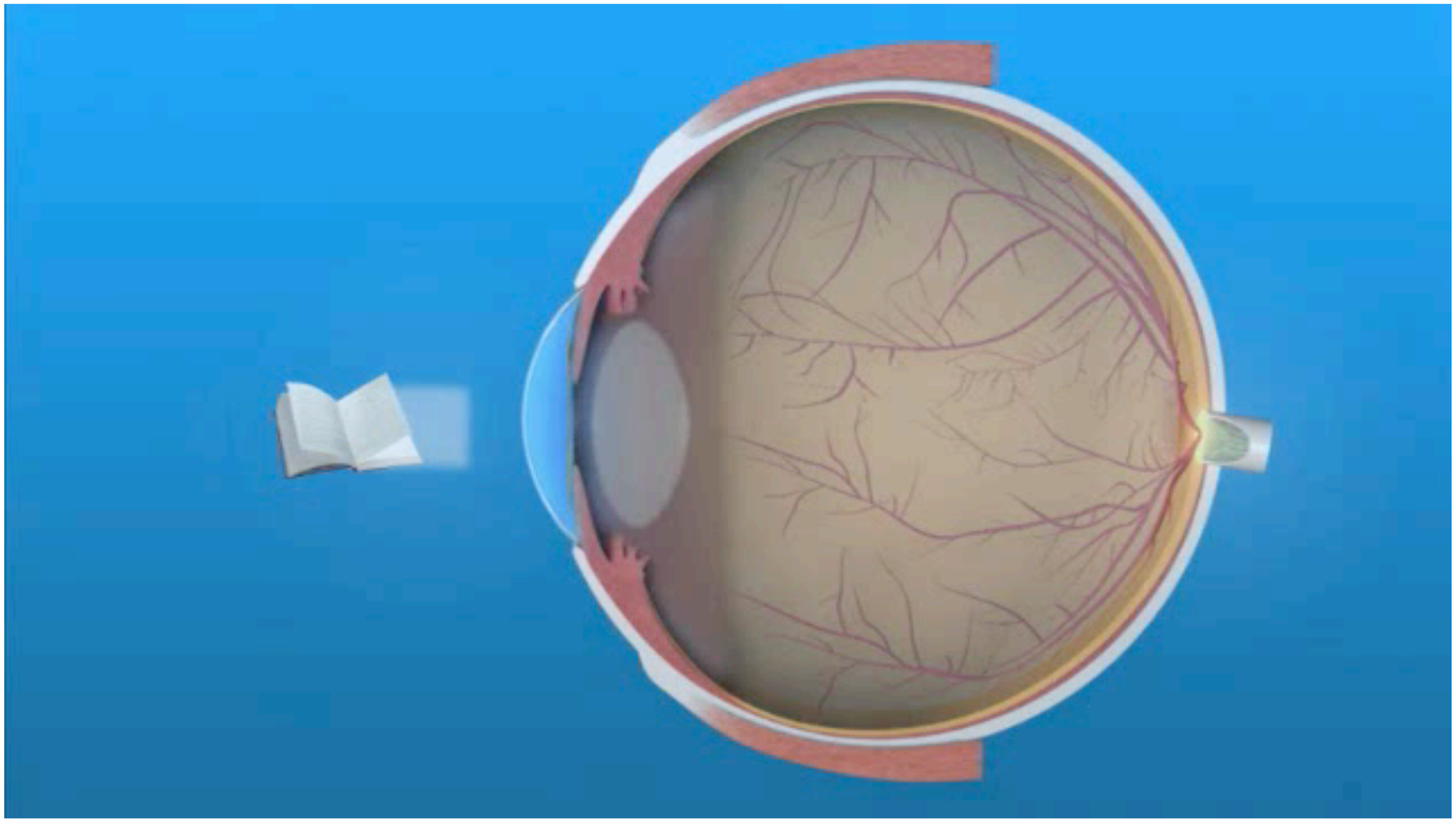
At around age 40, this flexibility gradually decreases; more difficult to see objects up close, unless the eye has nearsightedness.

Refractive errors: presbyopia



Refractive errors: presbyopia

Common eye diseases

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Cataract

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Symptoms include blurry vision, glare or light sensitivity, poor night vision, difficulty driving at night, yellowing or fading of colors, increased light required to read comfortably.

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Yellowing of colors is a symptom of cataract.

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- Treatment: surgery removes the cloudy lens and replaces it with an artificial intraocular lens implant (IOL).

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Cataract

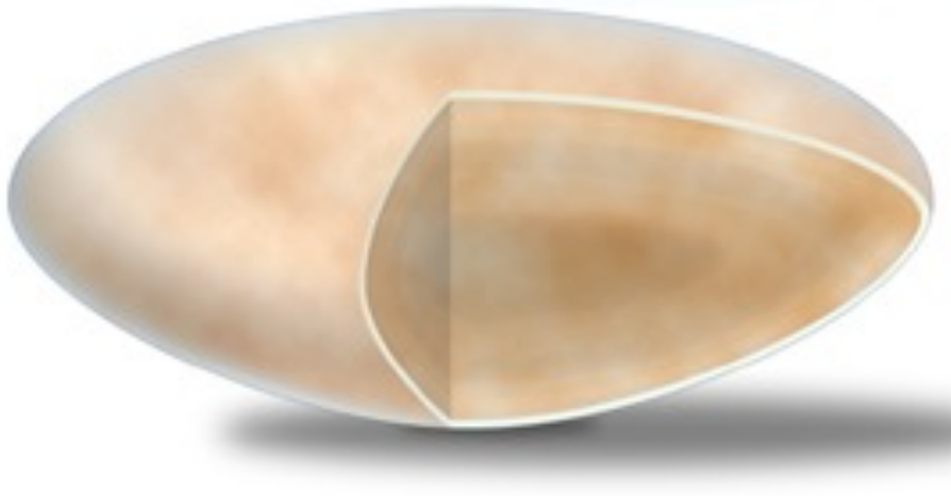
- Treatment: surgery removes the cloudy lens and replaces it with an artificial intraocular lens implant (IOL).
- If cataract symptoms are not adversely affecting your daily activities, you may not need surgery. Simply have your eyeglass prescription changed as needed.

What is a cataract?

What is a cataract?

- Clouding of the normally clear lens of the eye

Healthy lens



Lens with a cataract

Clouding of the normally clear lens of the eye . . .

. . . can be compared to a window that is frosted or yellowed.

What is a cataract?

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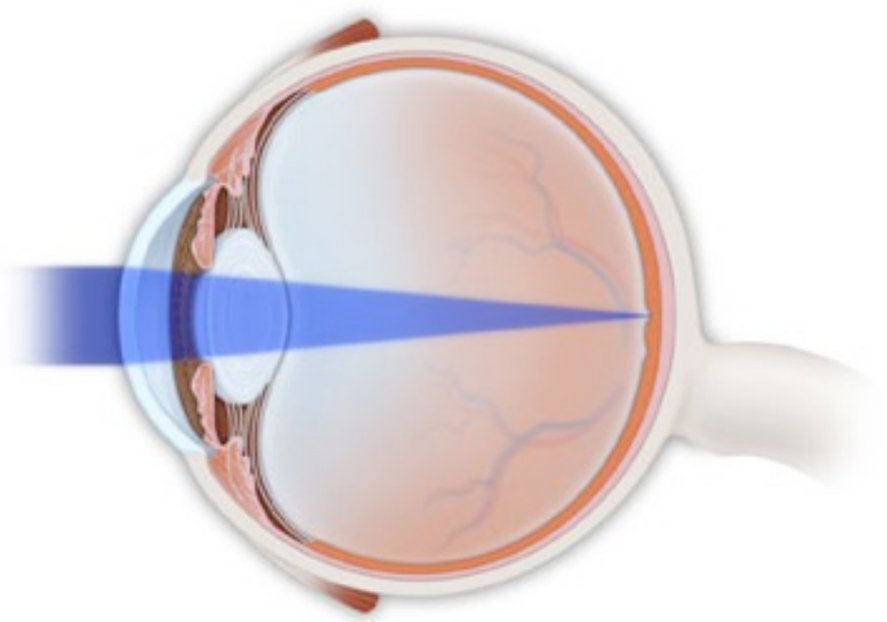
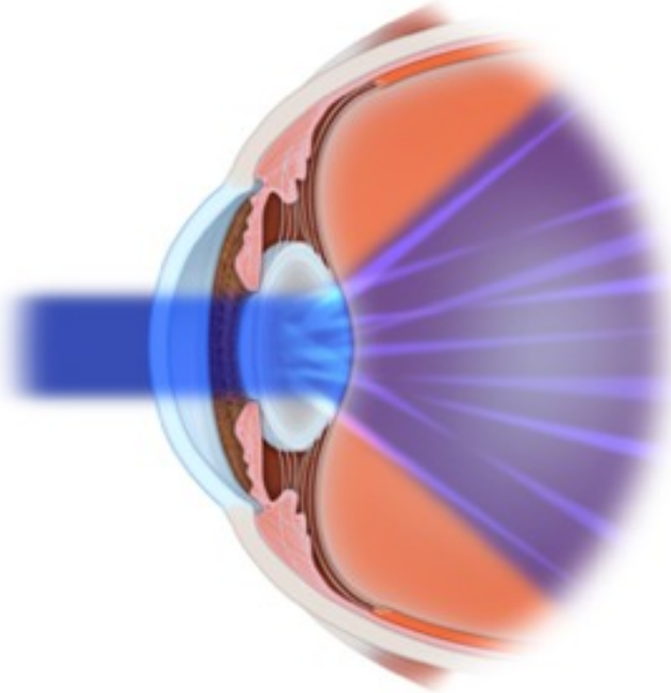


A clear lens refracts light onto the retina and fine-tunes our focusing ability.



A cloudy lens prevents light from focusing sharply on the retina.

A cataract is not:

A cataract is not:

- a film over the eye;
- caused by overusing the eyes;
- spread from one eye to the other; or
- a cause of irreversible blindness.

When should cataract surgery be performed?

When should cataract surgery be performed?

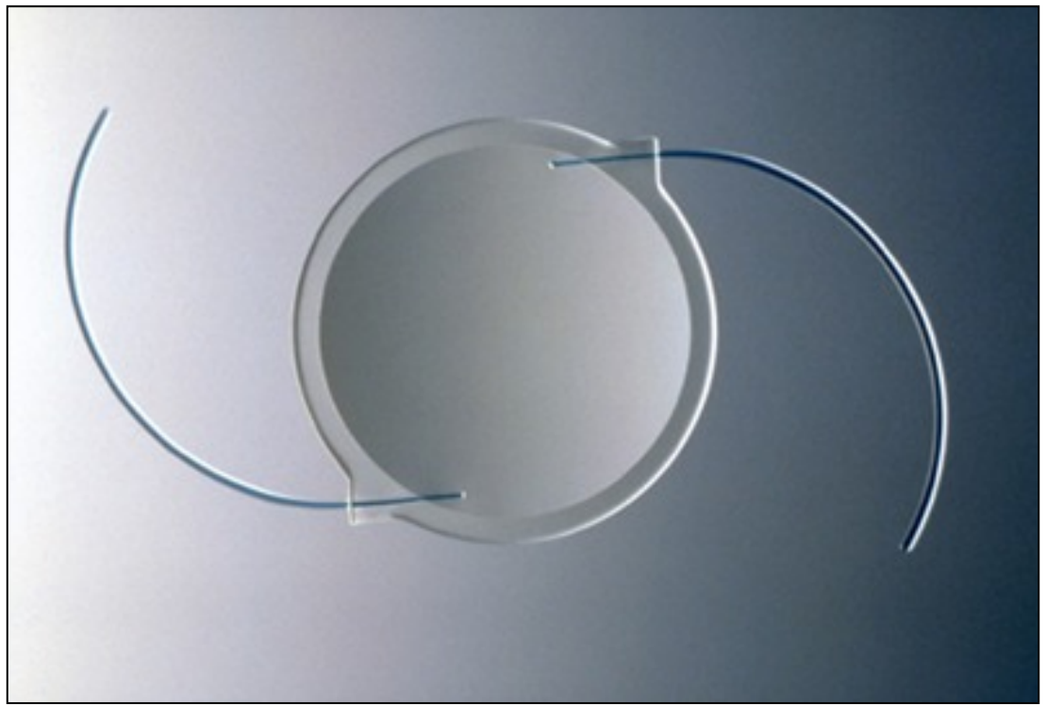
- When cataracts cause enough vision loss to interfere with your daily activities, such as:
  - performing your job;
  - driving safely;
  - reading and watching TV in comfort; and
  - taking medication.
- You and your ophthalmologist (Eye M.D.) should decide together when surgery is appropriate.

- Monofocal Intraocular Lens
- Mutifocal or Bifocal Intraocular Lens
- Toric Intraocular Lens

Types of IOLs

Types of IOLs

- **Monofocal**
  - The traditional IOL provides a single focus when you are not wearing glasses
  - Vision can be set for good near vision or good distance vision without glasses, but not both.



Monofocal IOL

What will my vision be like with a monofocal IOL?

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Monofocal lens set for good distance vision

Monofocal lens set for good near vision

What are multifocal and accommodative IOLs?

What are multifocal and accommodative IOLs?

- They are artificial lenses that are surgically implanted in the eye, replacing the eye's natural lens.
- They enable your eye to regain its focusing and refractive ability.
- They are considered to be presbyopia-correcting lenses, because they can provide good vision at close, intermediate and far distances, an ability that the eye's natural lens loses as we age.

What will my vision be like with a multifocal or accommodative IOL?

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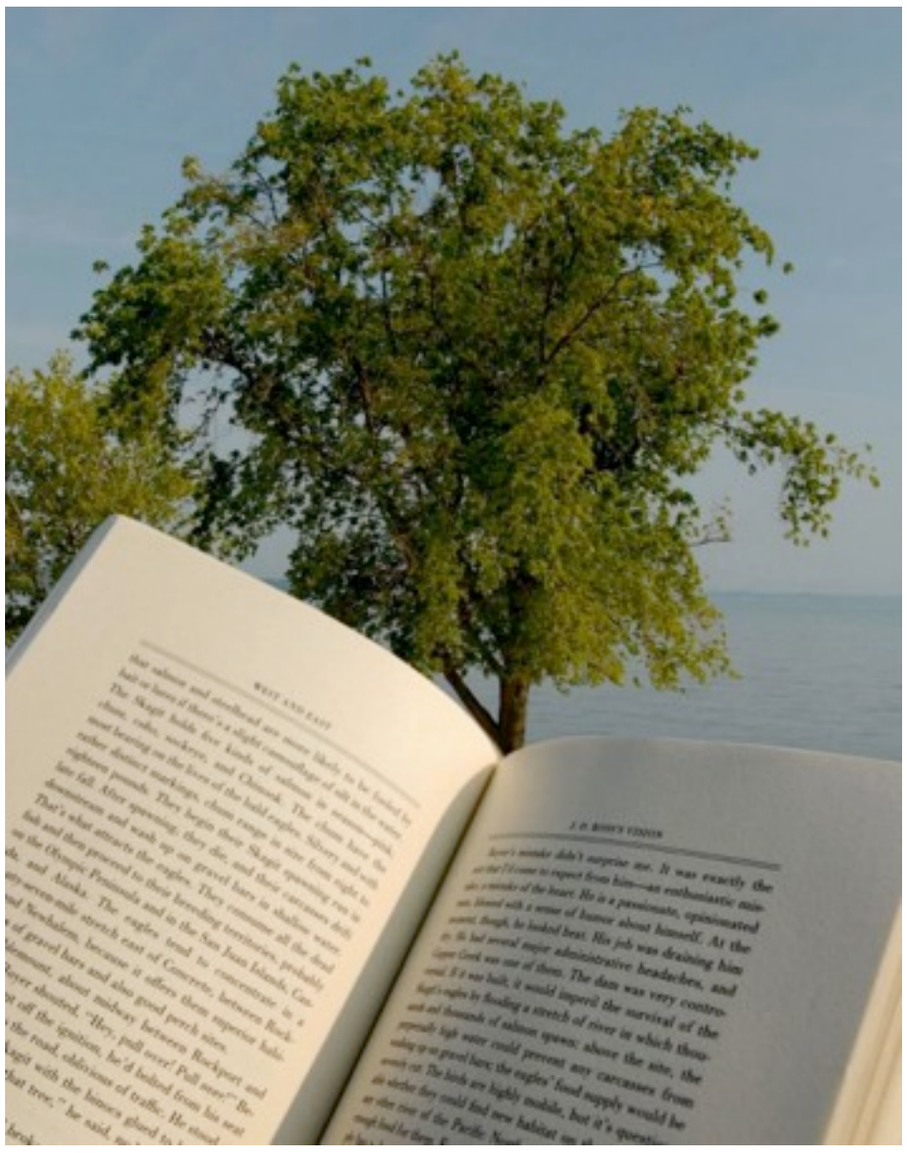


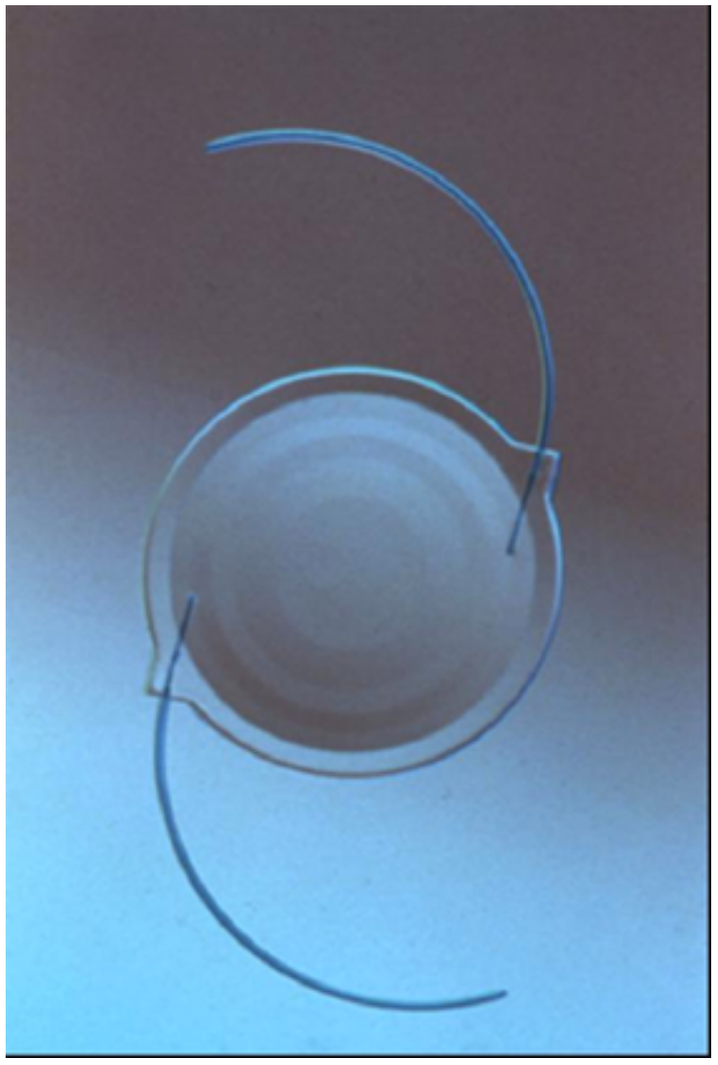
Lenses set for good near and distance vision

Types of IOLs

Types of IOLs

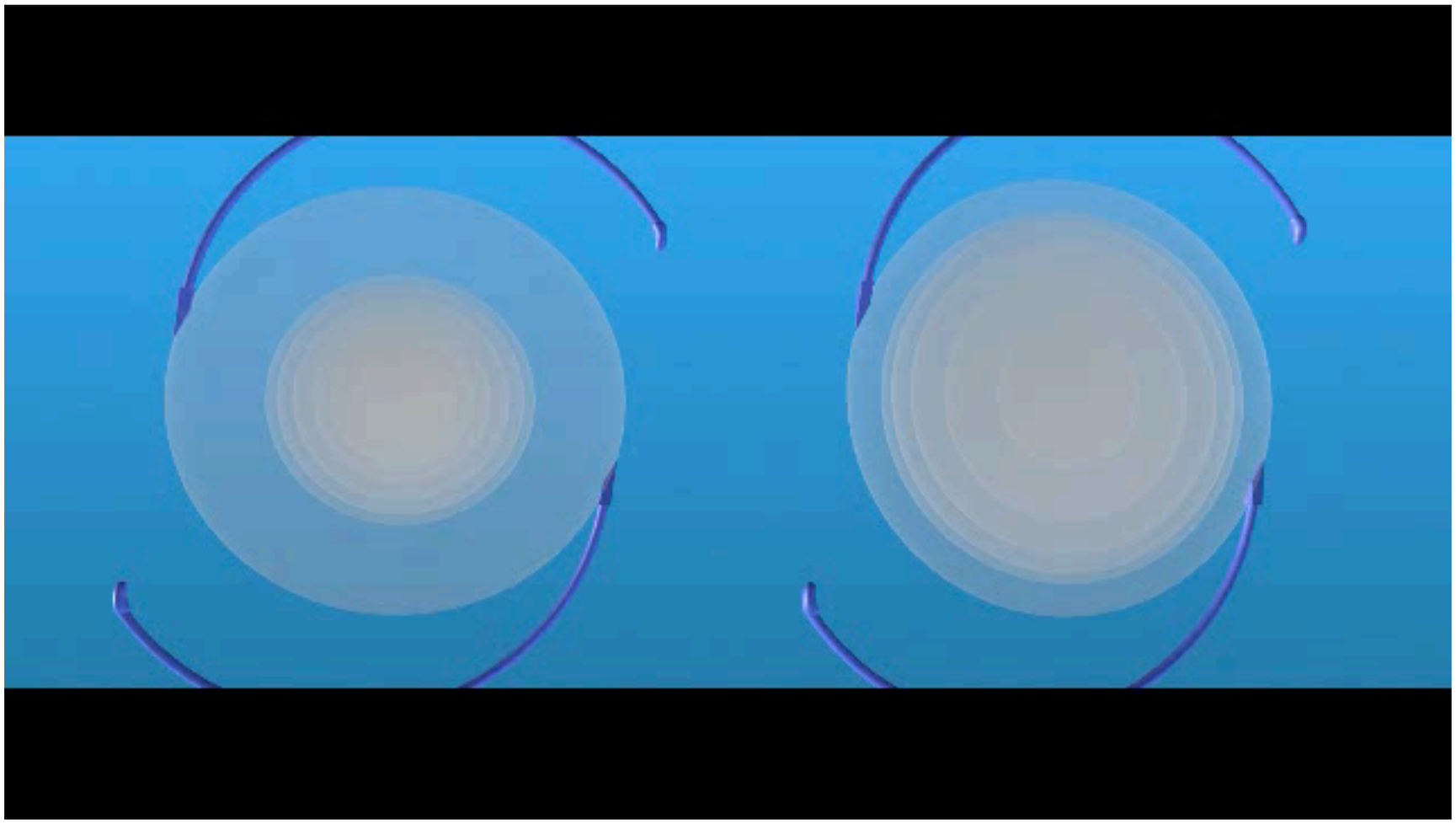
Multifocal

- A multifocal lens has several rings of different powers built into the lens.
- The part of the lens (ring) you look through will determine if you see clearly at a far, near or intermediate distance (this is sometimes called pseudo-accommodation).



A type of multifocal IOL

Multifocal IOLs



Multifocal IOLs

Types of IOLs

Types of IOLs

Accommodative

- The accommodative IOL is hinged to work in coordination with the eye muscles.
- The design allows the accommodative lens to move forward as the eye focuses on near objects, and move backward as it focuses on distant objects.

A type of accommodative IOL

Types of IOLs

Types of IOLs

- Toric
  - This type of lens corrects for astigmatism.
  - Monofocal IOLs specially designed to correct astigmatism that would usually be corrected by eyeglasses.
  - Toric IOLs will not entirely eliminate the need for eyeglasses. However, people with astigmatism who have toric IOLs should be able to see better without eyeglasses than if they had a traditional IOL instead.

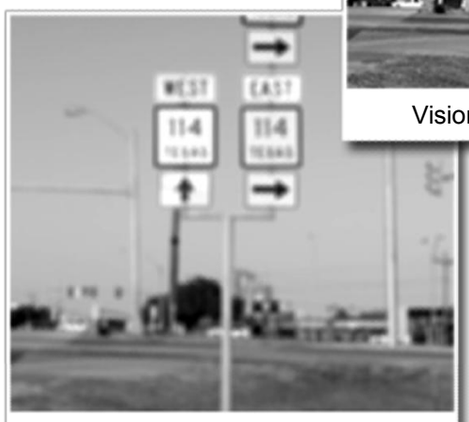
Monovision Correction

- The dominate eye is corrected for distance
- Reduces dependance on glasses
- Vision always correctable
- No extra cost

So What About Astigmatism?

How do we treat it?

Vision without astigmatism *

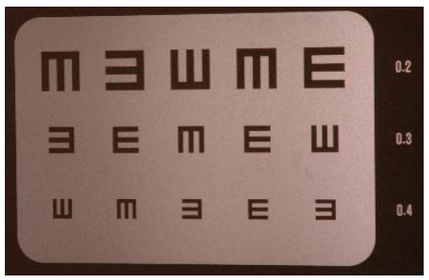


Vision with astigmatism 1.5D cyl @ 90 *

Vision with astigmatism 3.0D cyl @ 90 *

* Simulated Images

Quality of vision is deteriorated considerably by astigmatism



No astigmatism

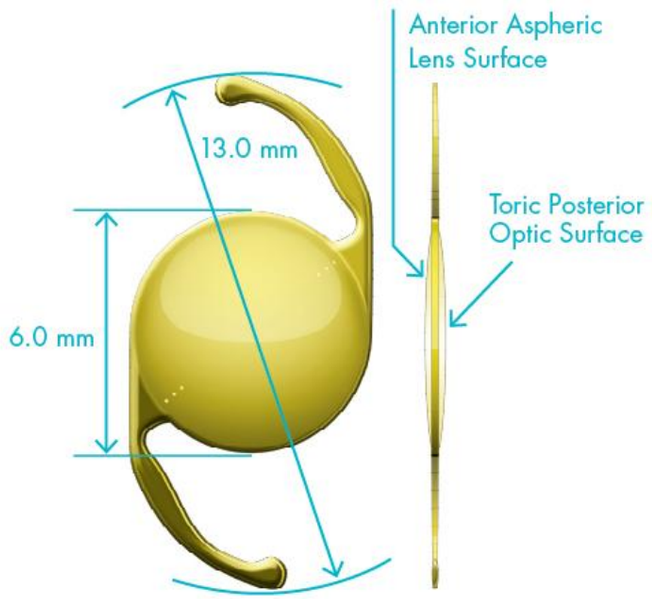
1.0 D astigmatism

2.0 D astigmatism

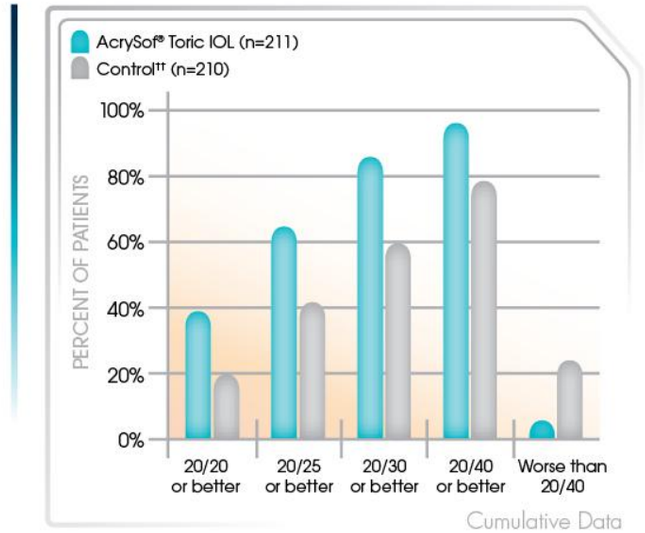
AcrySof® IQ Toric IOL

›Newest monofocal IOL builds on long line of innovation from Alcon

›Takes the trusted platform for **precise astigmatism correction** and adds the enhanced image quality of an **aspheric lens**



Improved Uncorrected Distance Visual Acuity



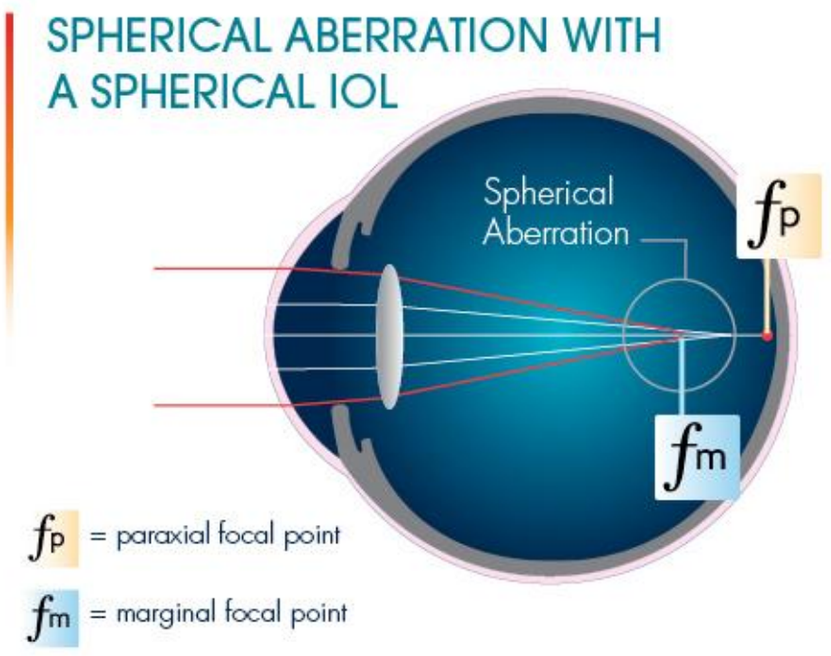
› 94% of patients implanted achieved uncorrected distance visual acuity of 20/40 or better[1].

†† AcrySof® Single-Piece (SA60AT)

Spherical Aberration

The Problem: Occurs when light rays are over-refracted at periphery of optics.

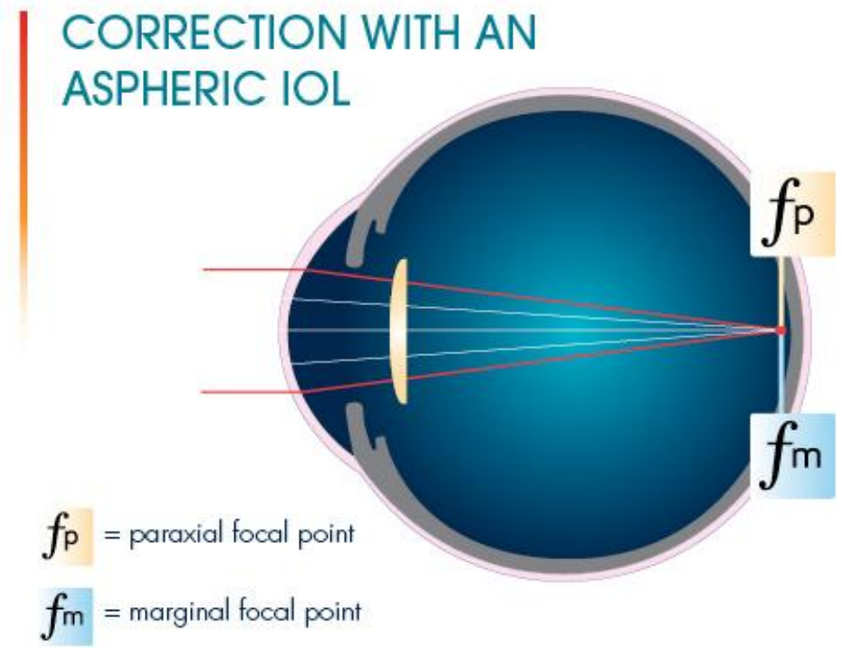
› This region of defocused light can reduce image quality.



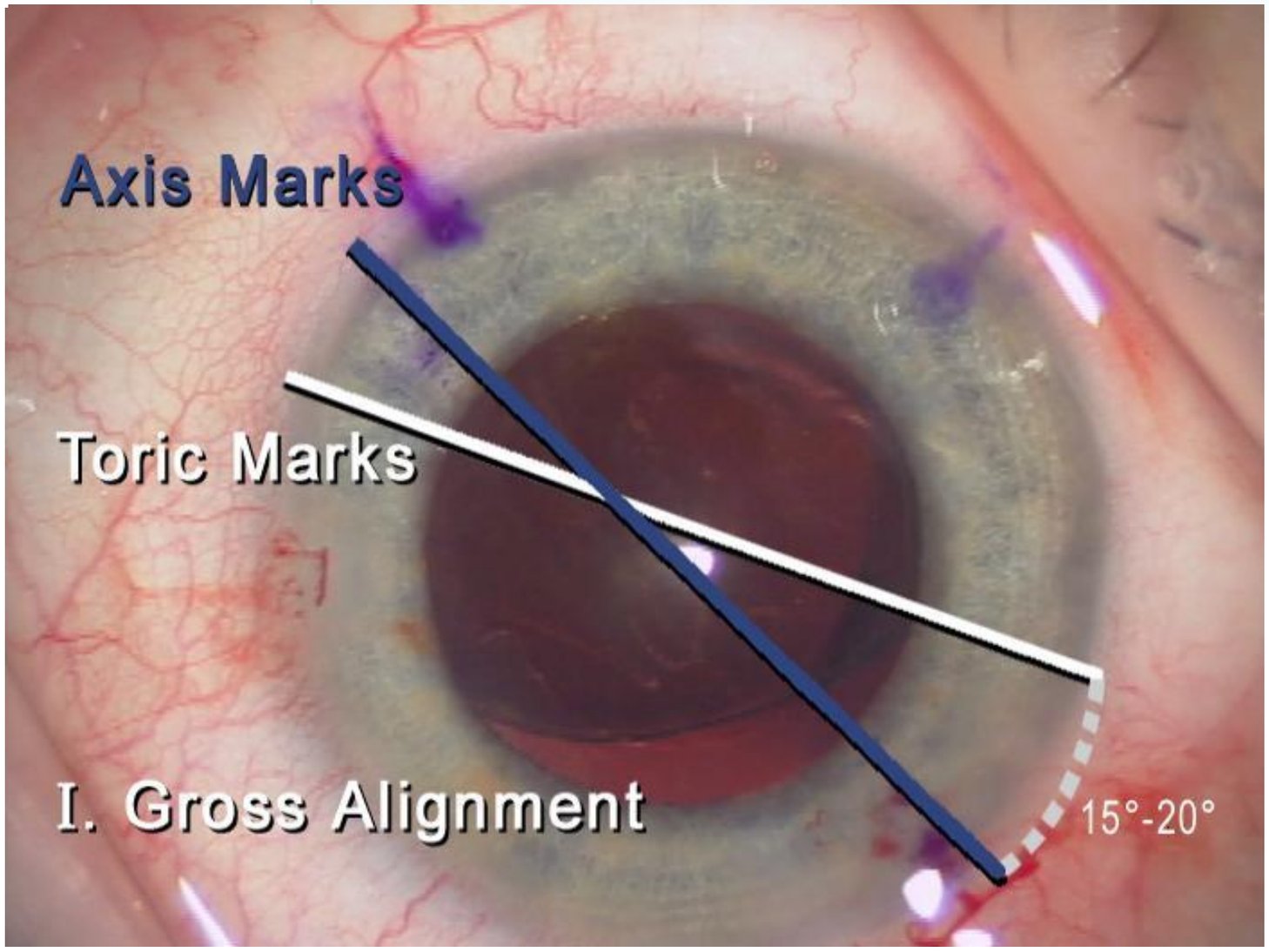
Aspheric Optics

The Solution: Negative spherical aberration aligns the light rays to compensate for positive spherical aberration.

› This results in enhanced clarity and image quality.



AcrySof® IQ Toric IOL



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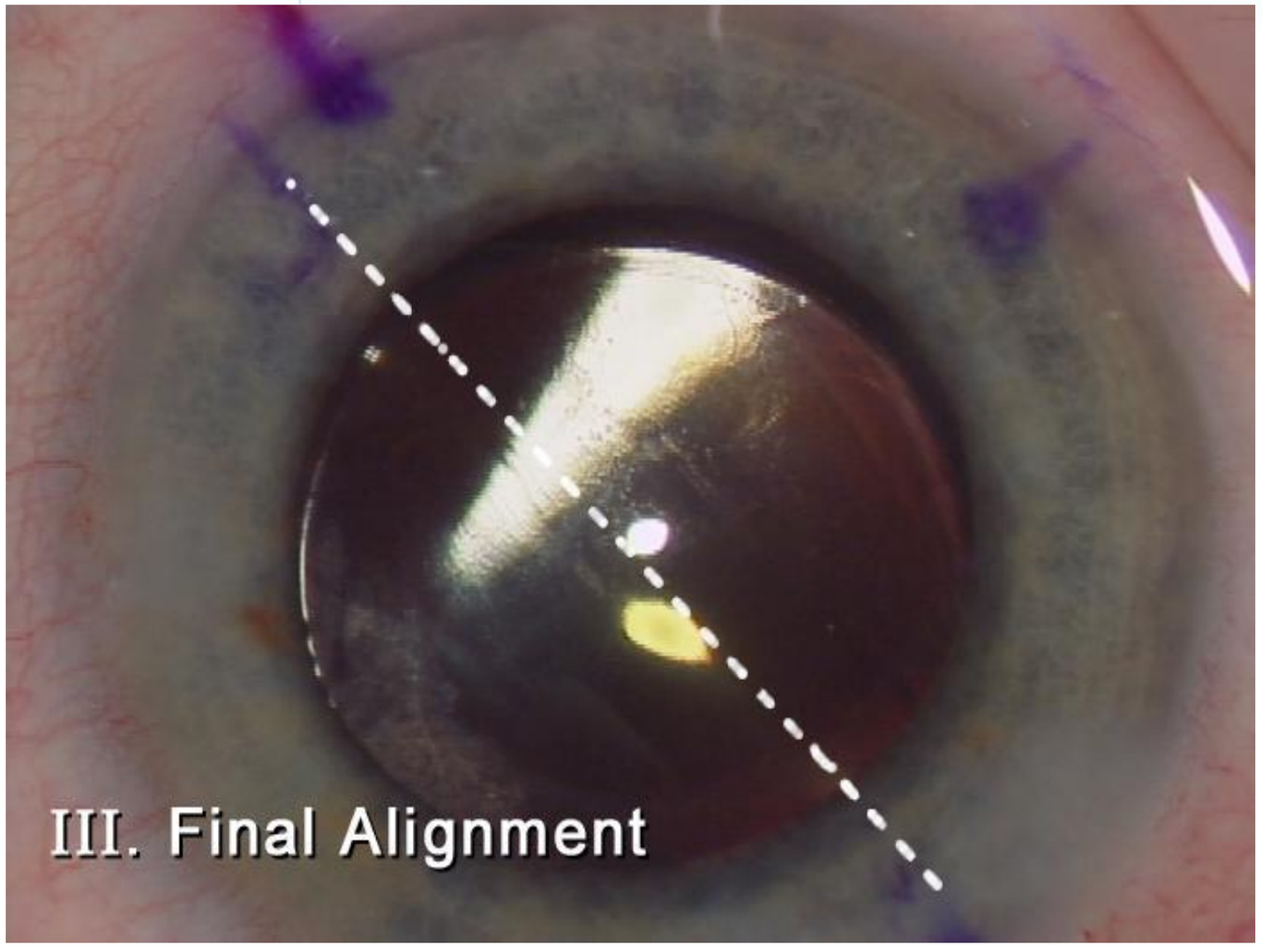
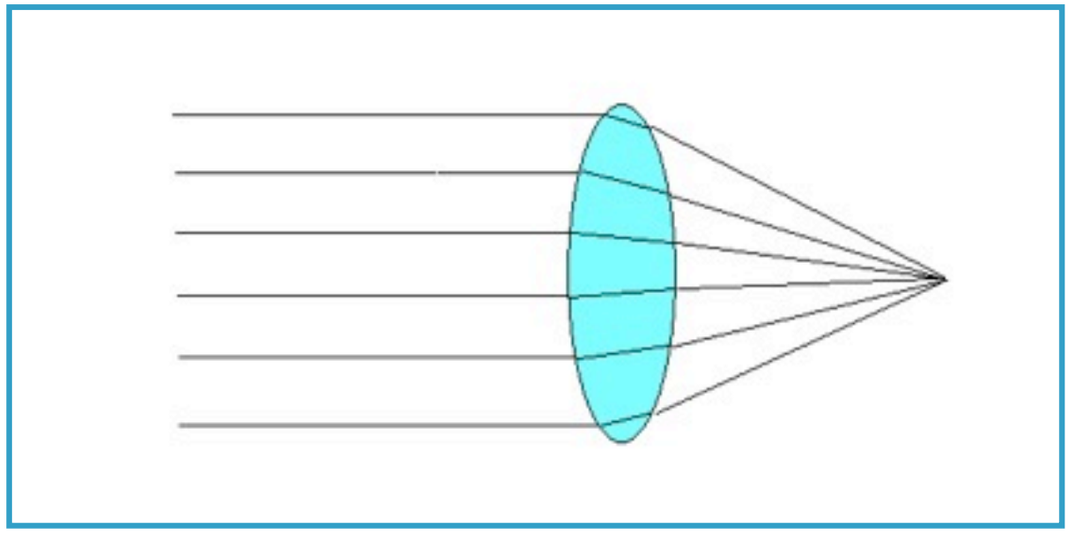


Refraction vs. Diffraction

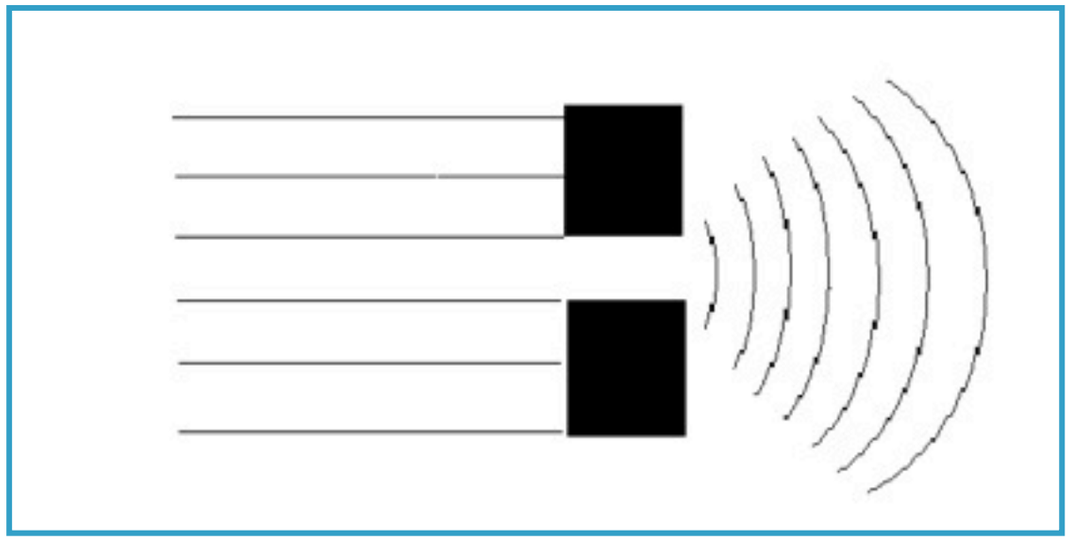
What is refraction?

- The bending of light as it passes through materials of differing refractive indices



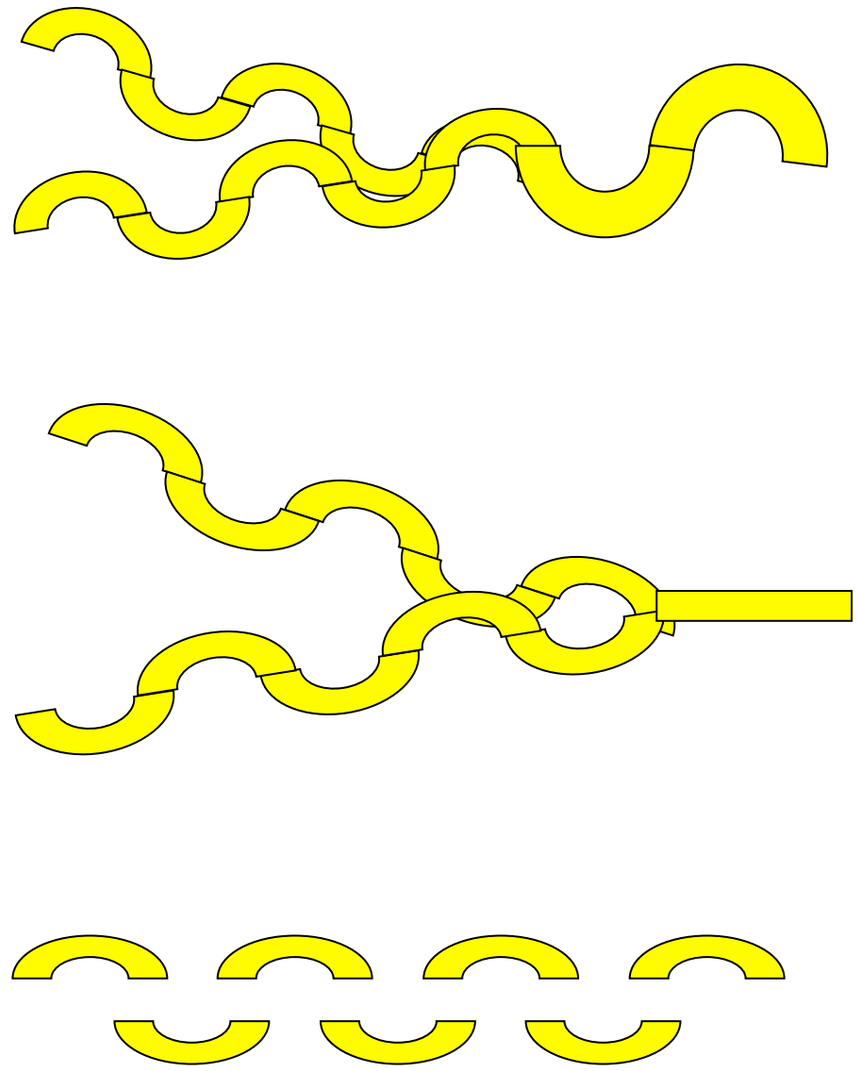
What is diffraction?

- The spreading of light as it encounters an edge or step



Cassin B. Dictionary of Eye Terminology Fourth Edition; Pages 88, 225.

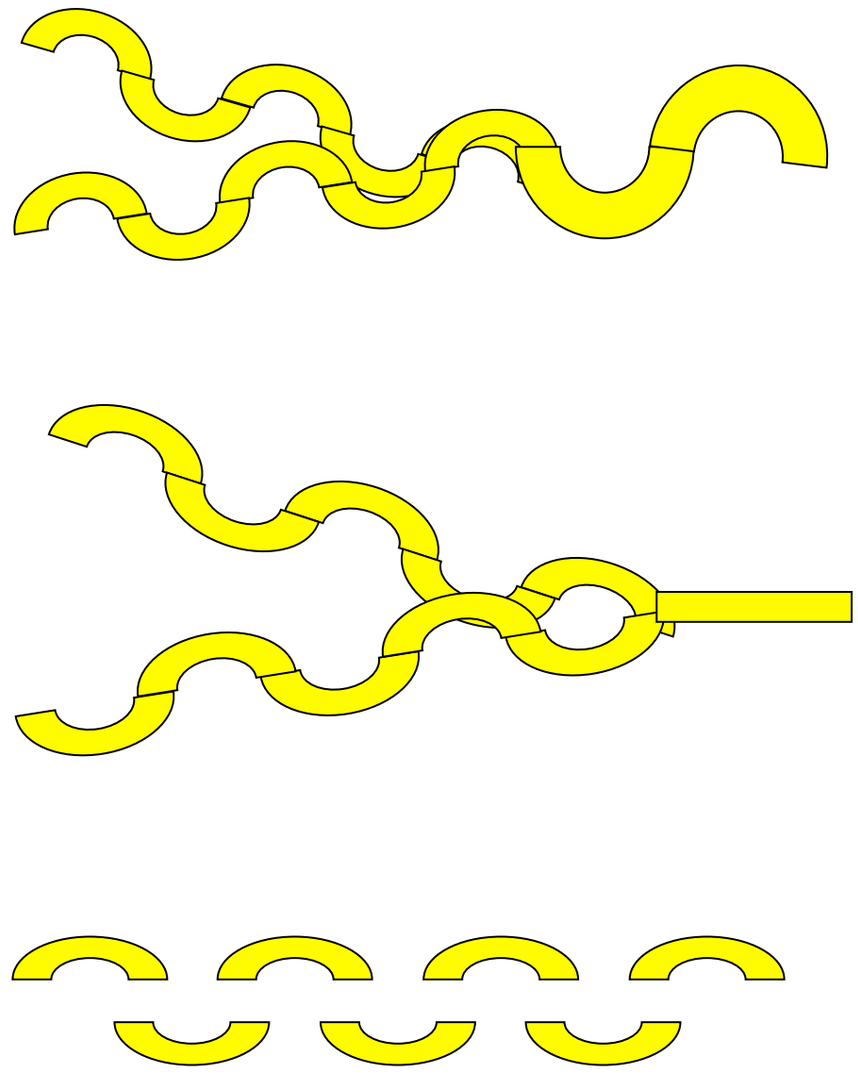
The Wave Nature of Light



David Cassidy, Gerald Holton, James Rutherford (2002). *Understanding Physics.* Pgs 382-384

The Wave Nature of Light

- If waves work together, they produce a stronger wave



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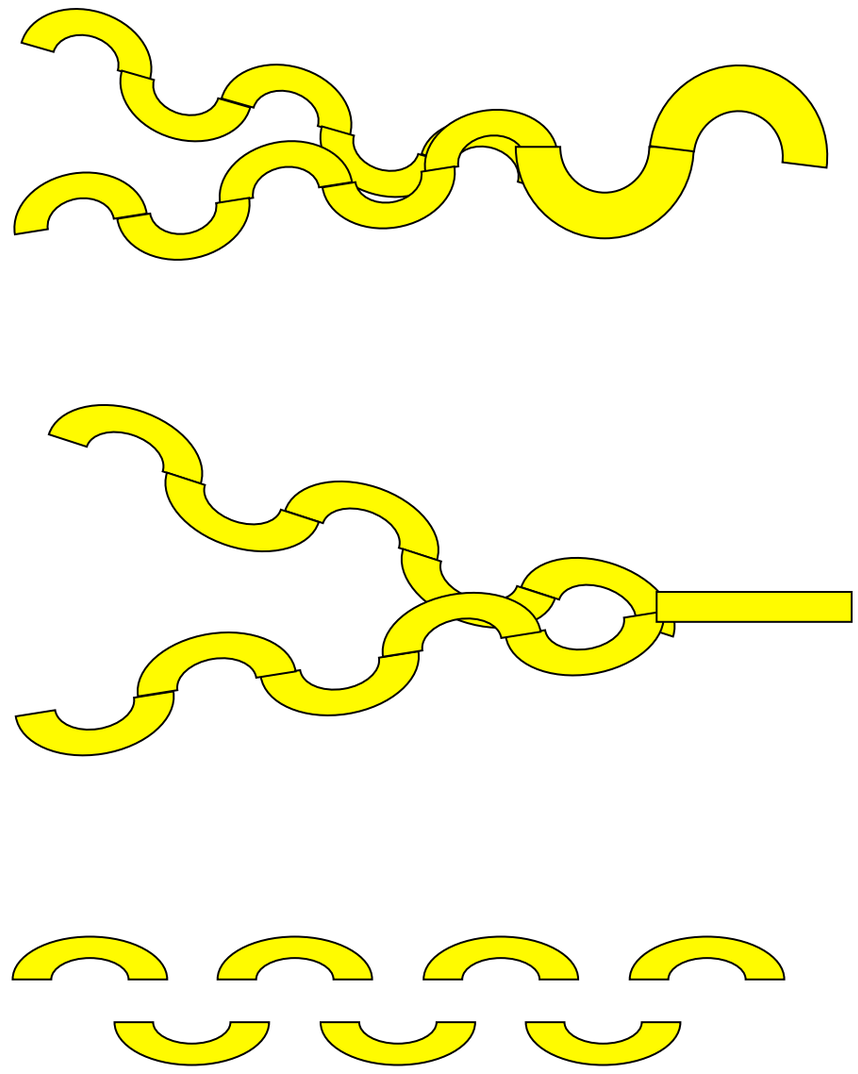

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The Wave Nature of Light

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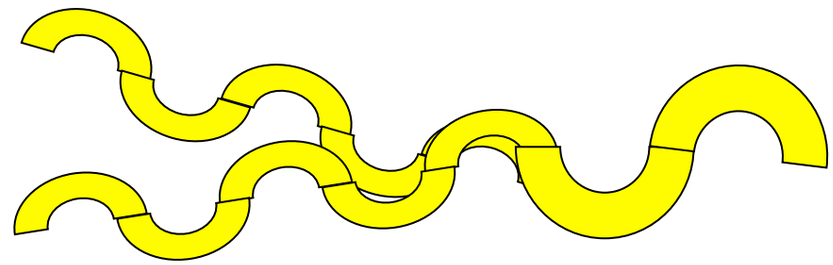
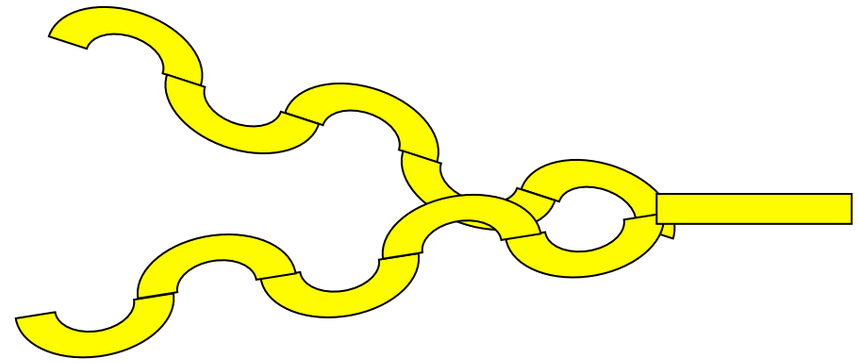
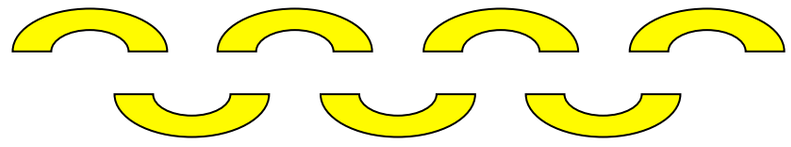


- Waves cancel each other out if they are opposites





David Cassidy, Gerald Holton, James Rutherford (2002). *Understanding Physics.* Pgs 382-384

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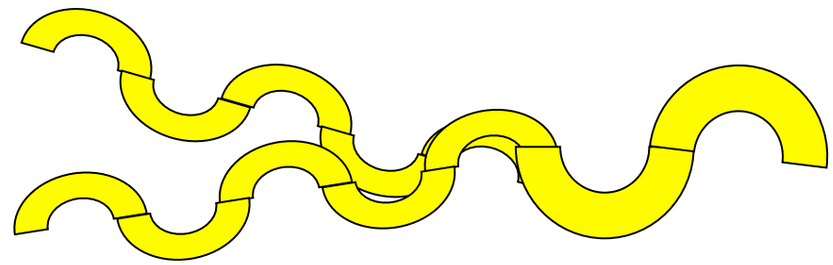

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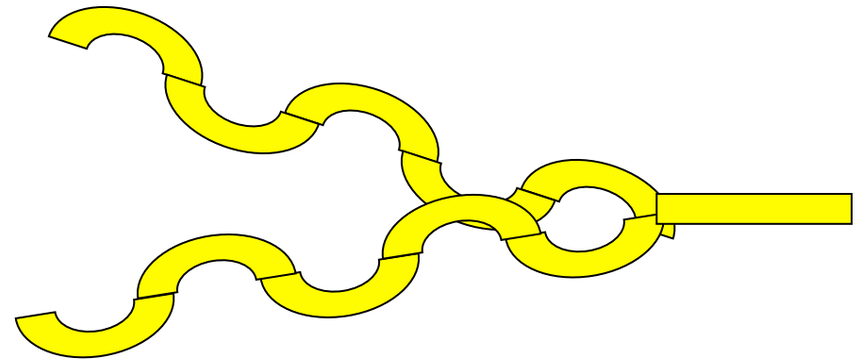

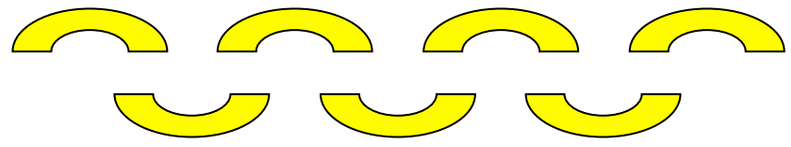

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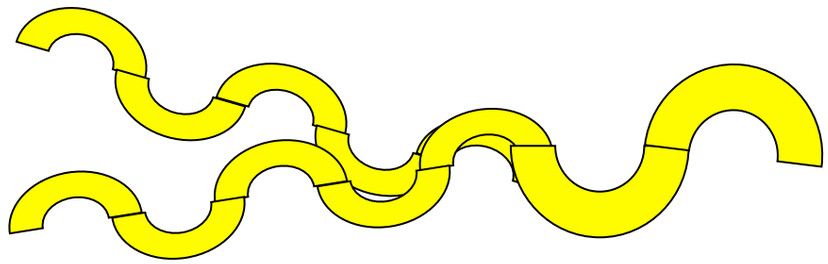

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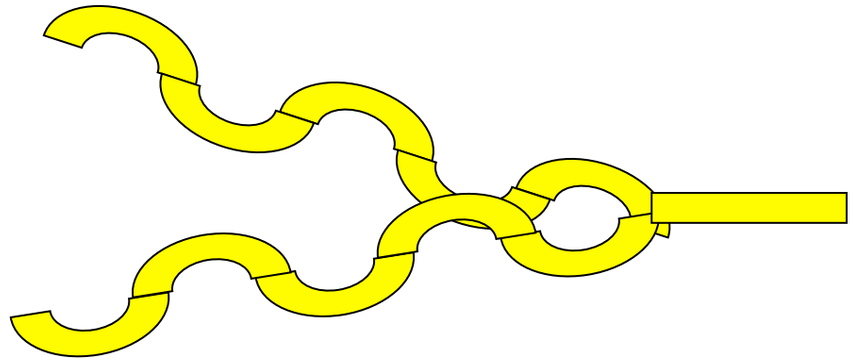
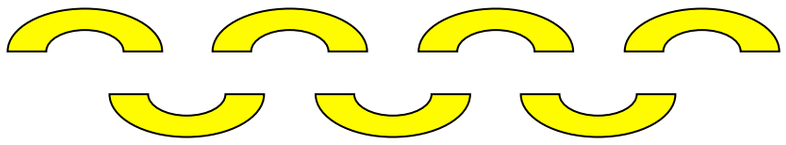


- Waves can also be separated into individual components called **phases**

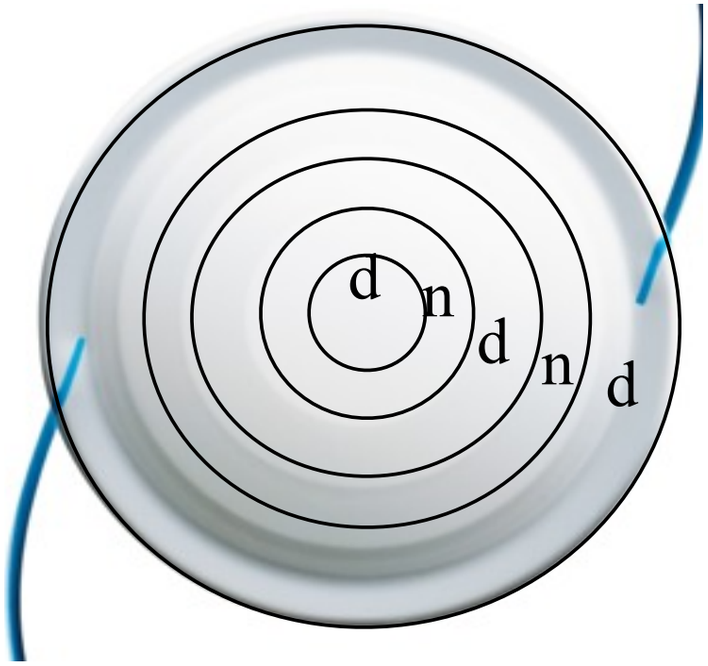


David Cassidy, Gerald Holton, James Rutherford (2002). *Understanding Physics.* Pgs 382-384

Refractive Zones vs. Diffractive Steps

Refractive multifocals often use alternating zones

- Zones work independently
- Each zone creates one focal point



Diffractive multifocals use a series of steps (gratings)

- Steps work together
- Each step creates multiple focal points

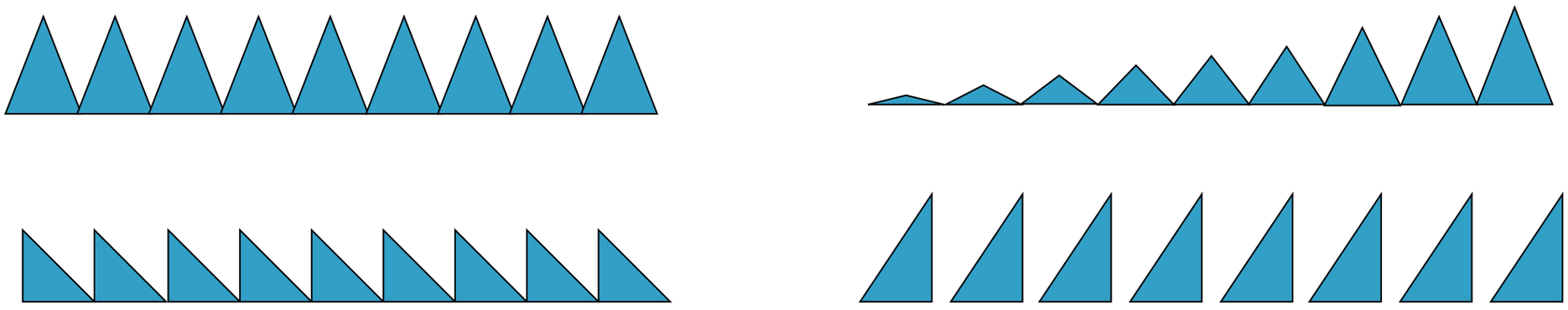
Fine I, et al. Refractive Lens Surgery. 2005. Pgs. 137-150

Diffractive Steps at Work

Diffractive steps (gratings) manage light by combining, canceling, and/or breaking it down into phases

The size, shape, spacing, and location of diffractive steps in a lens determines:

- The add power for generating the near image
- Distance between focal points
- Amount of energy allocated to a focal point



Types of Diffractive Multifocal IOLs

Non-Apodized Full Optic Diffractive

- Pupil Independent
- Balanced for near and far regardless of light conditions
- Quality near image in low light

TECNIS® Multifocal IOL

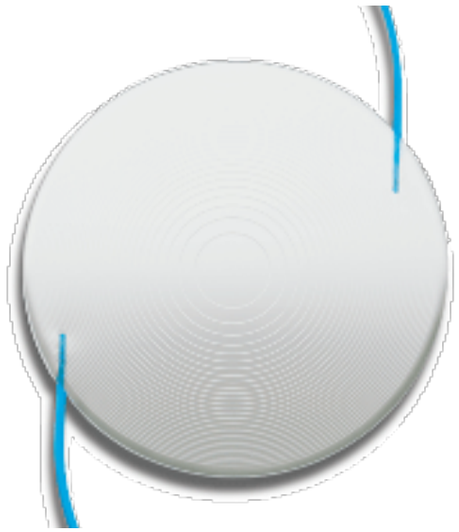
Apodized Diffractive Hybrid

- Pupil Dependent
- Distance dominant in low light
- Reduced functionality at near in low light

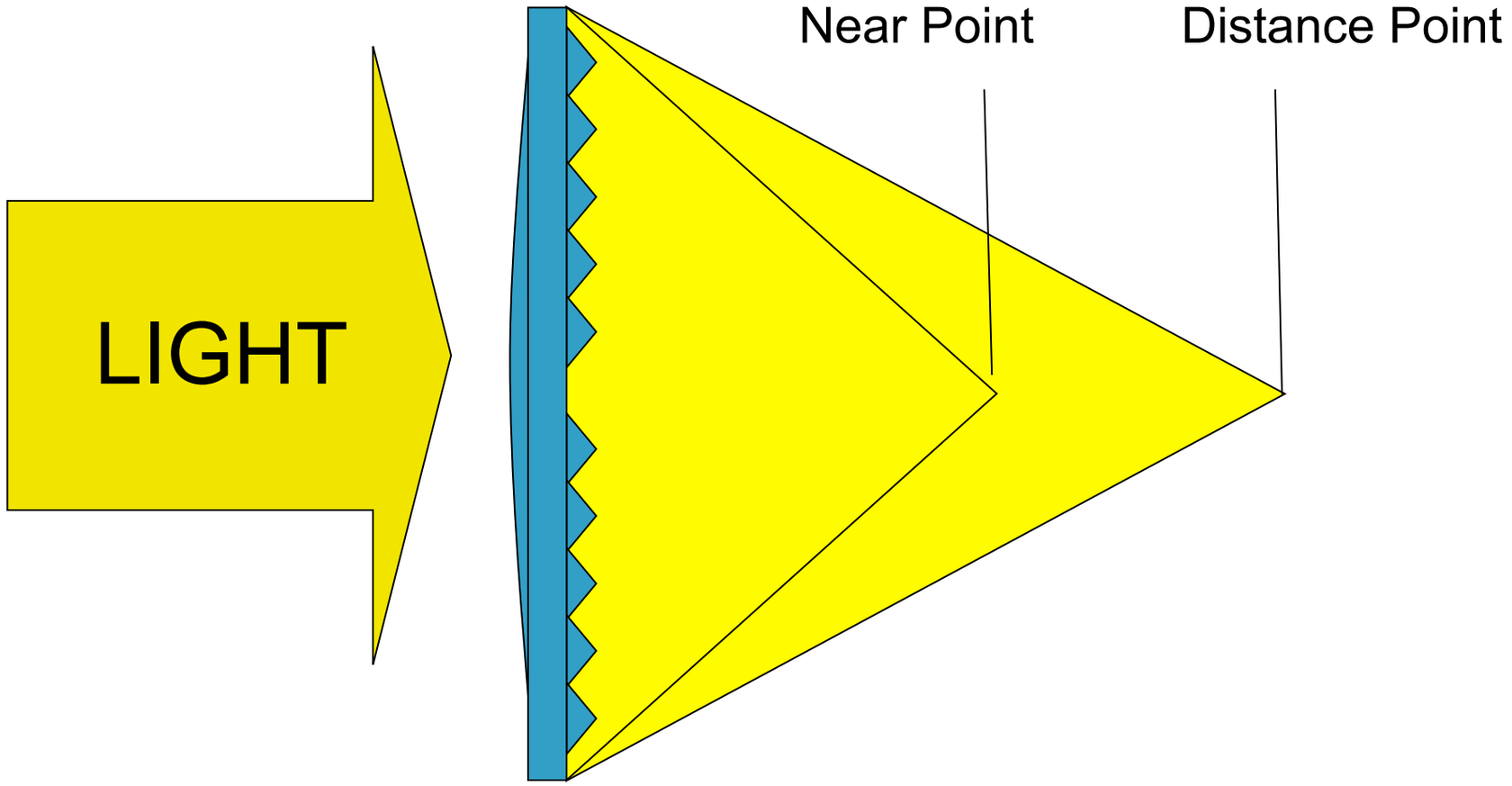
AcrySof® ReSTOR® IOL

Fine I, et al. Refractive Lens Surgery. 2005. Pgs. 137-150

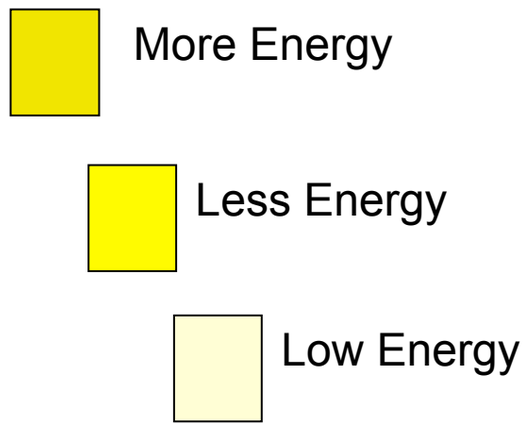
Non-Apodized Step Heights with Large Aperture



TECNIS® Multifocal IOL



Light energy is balanced between the near and far focal points



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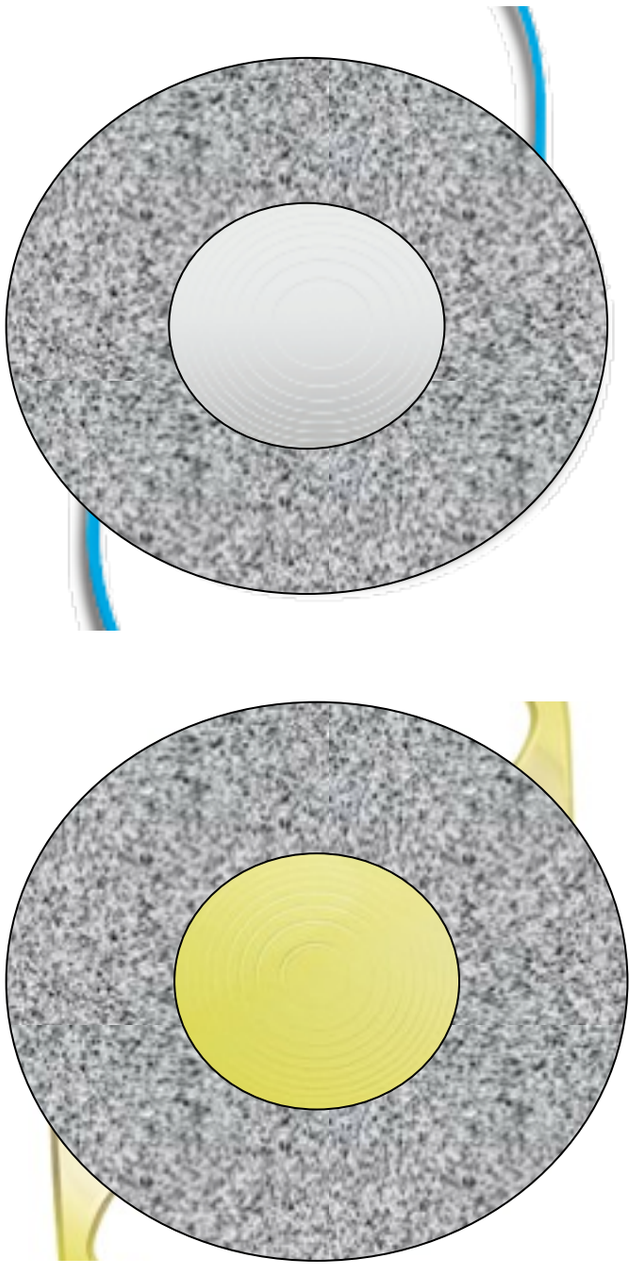
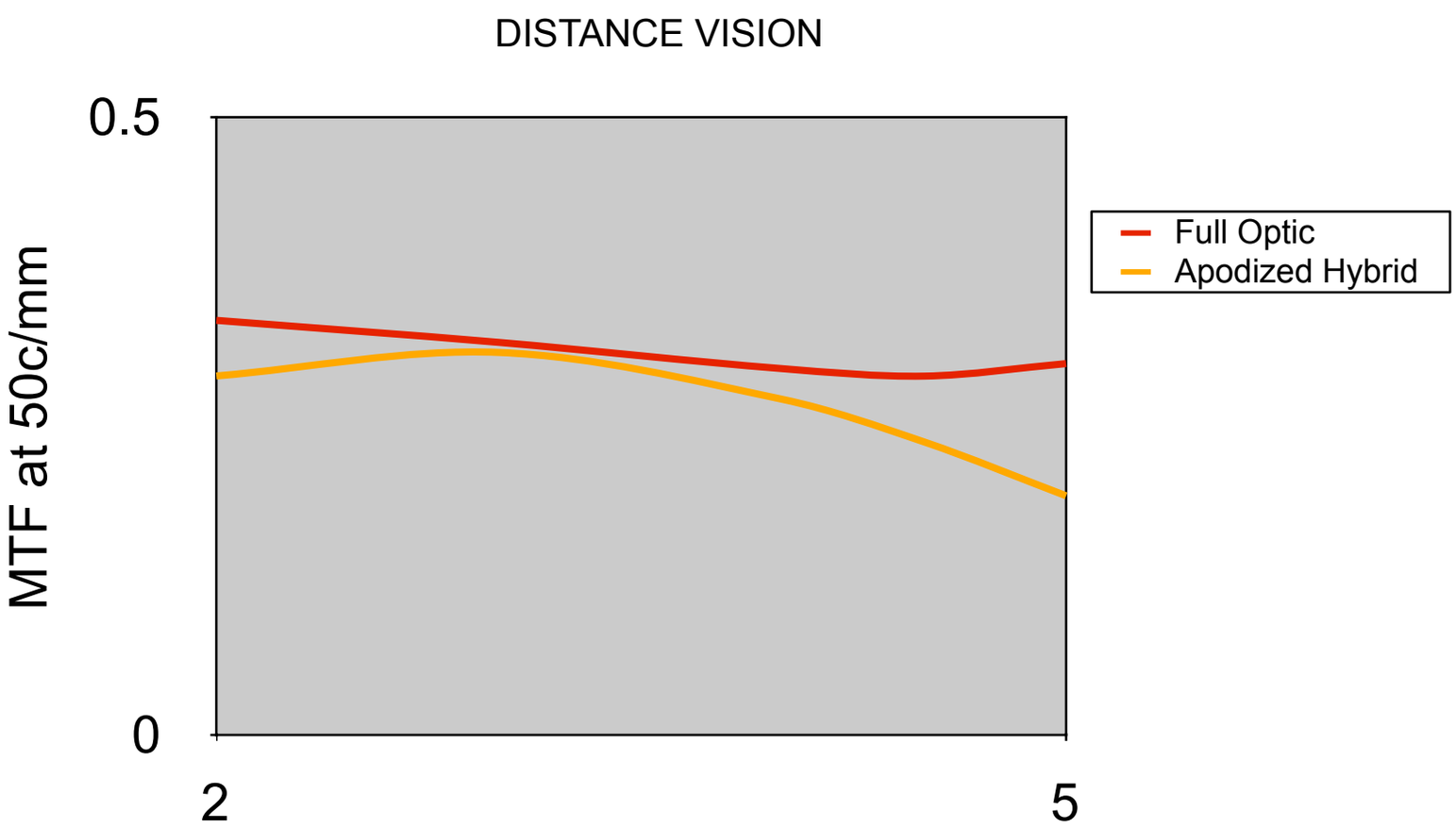
Pupil Size & Diffractive Optics





Data on File. Advanced Medical Optics, Inc.

TECNIS® Multifocal Acrylic IOL

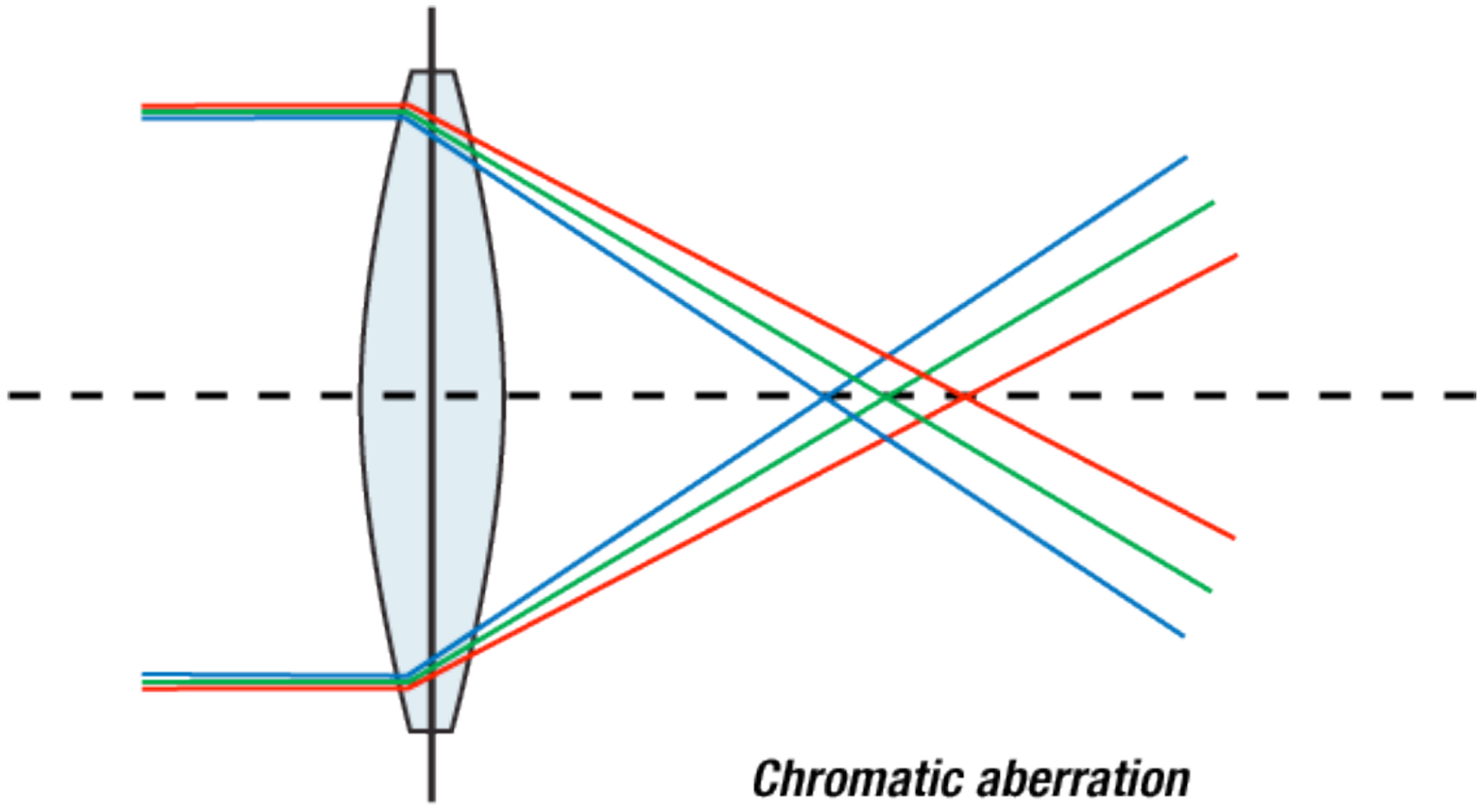
Designed with:

- Anterior aspheric surface to correct **spherical aberration** to zero
- Posterior diffractive surface reduces **chromatic aberration** in all light conditions

Chromatic Aberration Correction

What is chromatic aberration?

Occurs when light is separated into its spectral components and these wavelengths are refracted differently to create multiple focal points

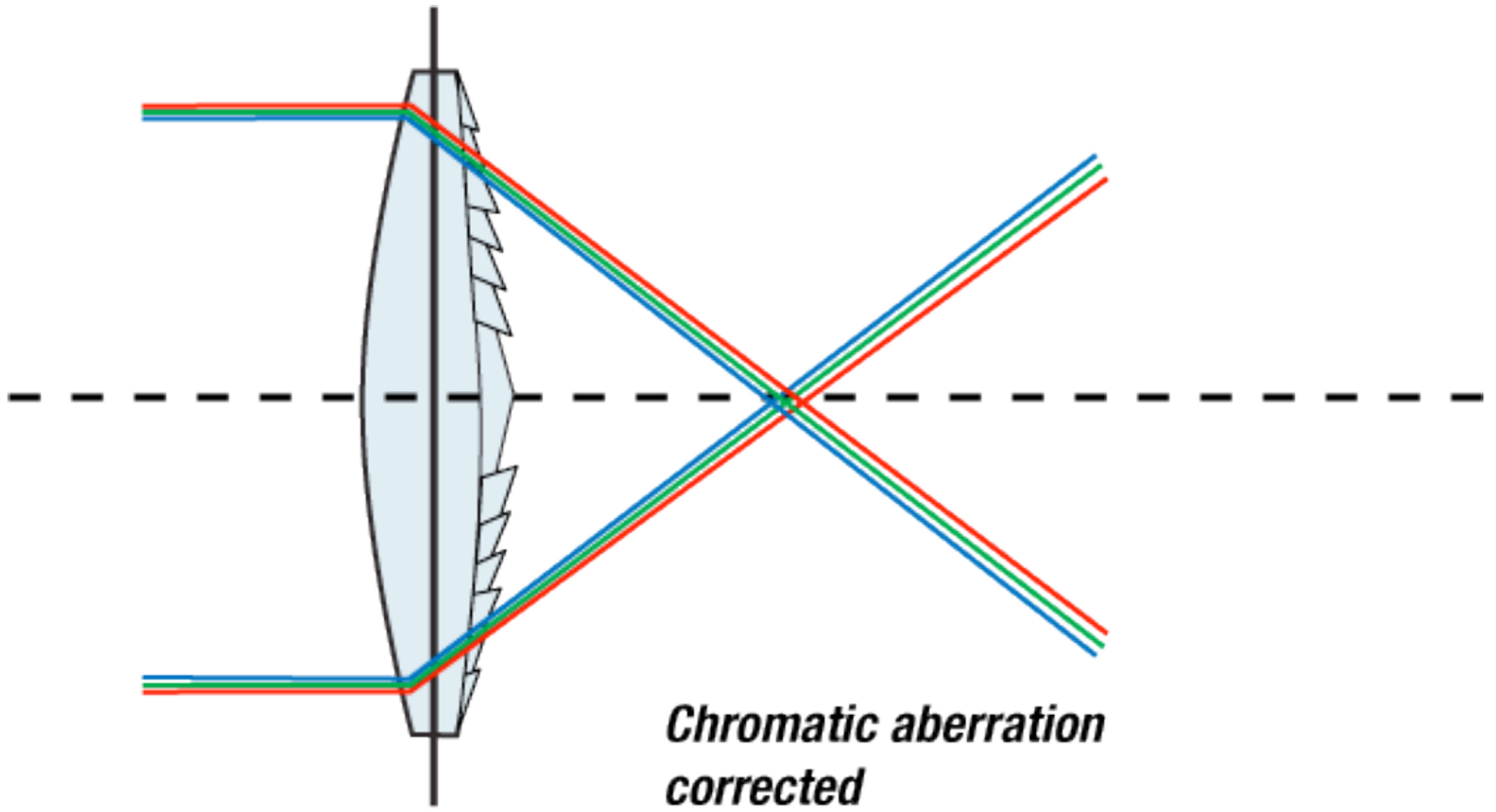


Chromatic aberration

TECNIS® MIOL: Posterior Diffractive Design Reduces Chromatic Aberration

Higher add power also corresponds to more correction of chromatic aberration at the near focal point

- TECNIS® MIOL has a +4.0 add



Spherical and Chromatic Aberration

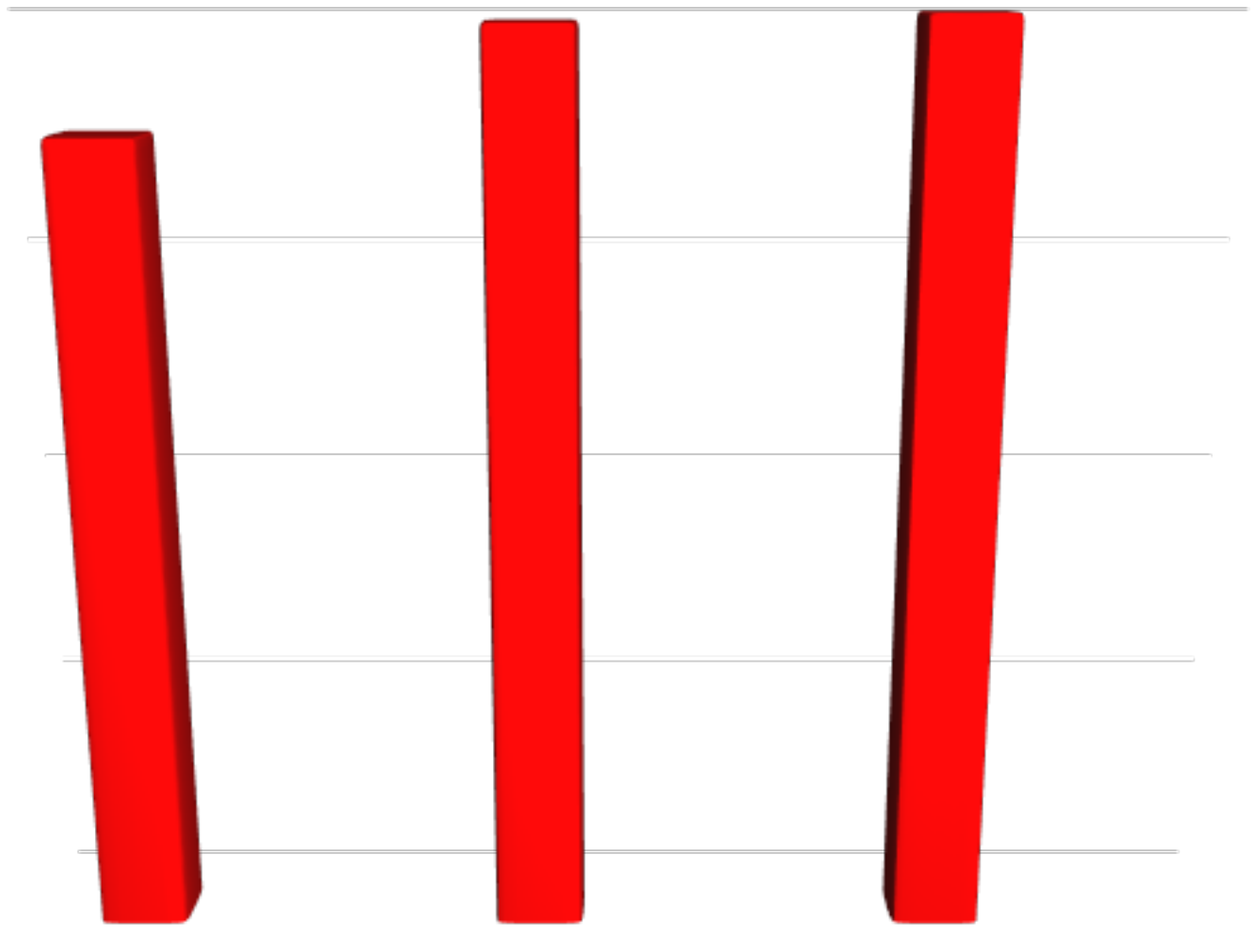
Several studies have shown the correction of chromatic aberration and spherical aberration **together is more beneficial** than the sum of the two individual corrections*

This is a major distinguishing factor for the new TECNIS® Multifocal Acrylic IOL

*Yoon GY, Williams DR. *J Opt Soc Am A Opt Image Sci Vis*. 2002;19:266-275.
Manzanera S, et al. *Ophthalmol Vis Sci*. 2007;48:E-Abstract 1513.

Binocular Corrected Distance Visual Acuity

88% of subjects were 20/20 or better BCDVA, with a mean BCDVA of 20/18.



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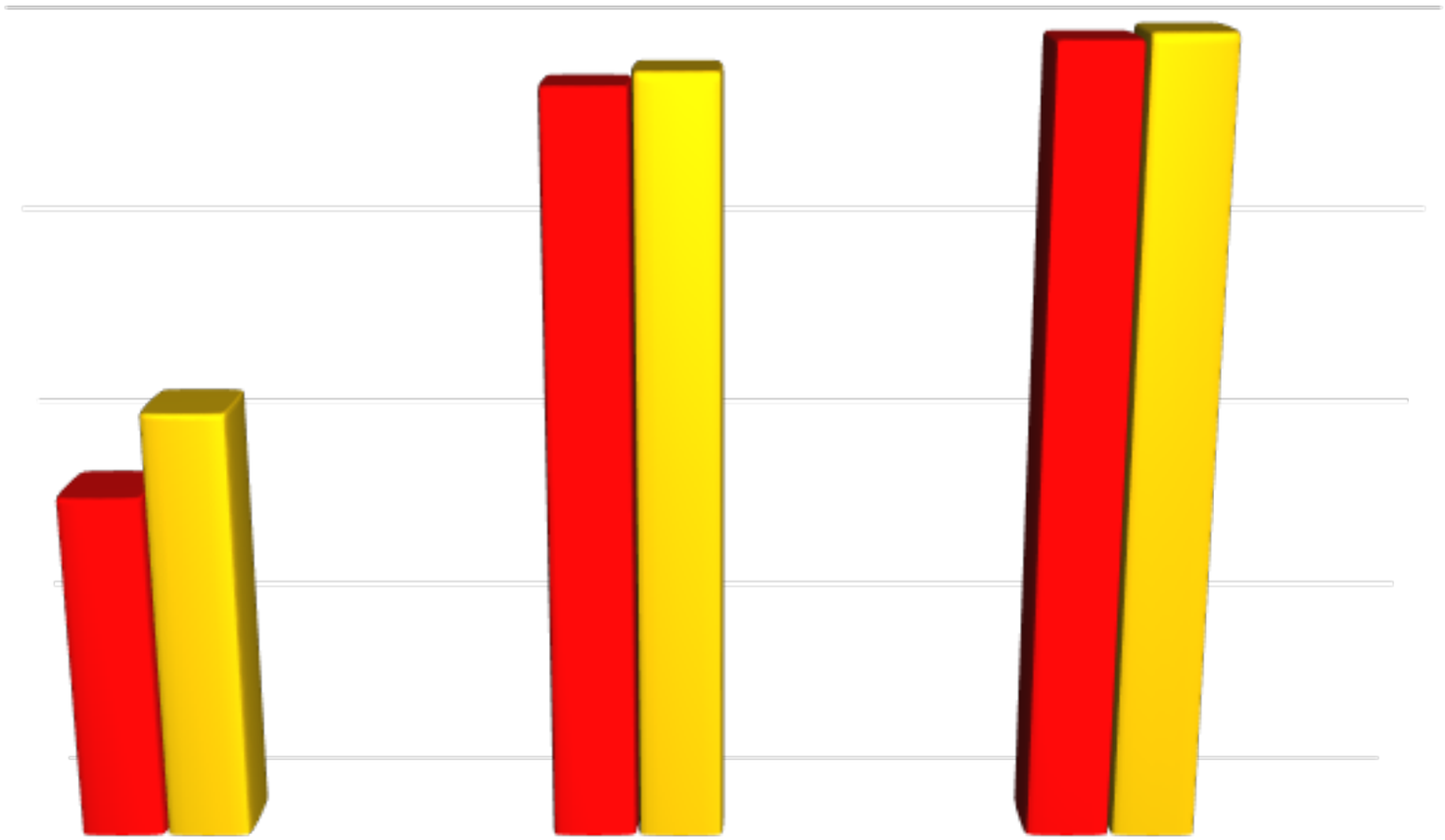
Abbott Medical Optics

Binocular Distance-Corrected Near Visual Acuity

More than 94% of subjects were 20/32 or better with distance correction at near.



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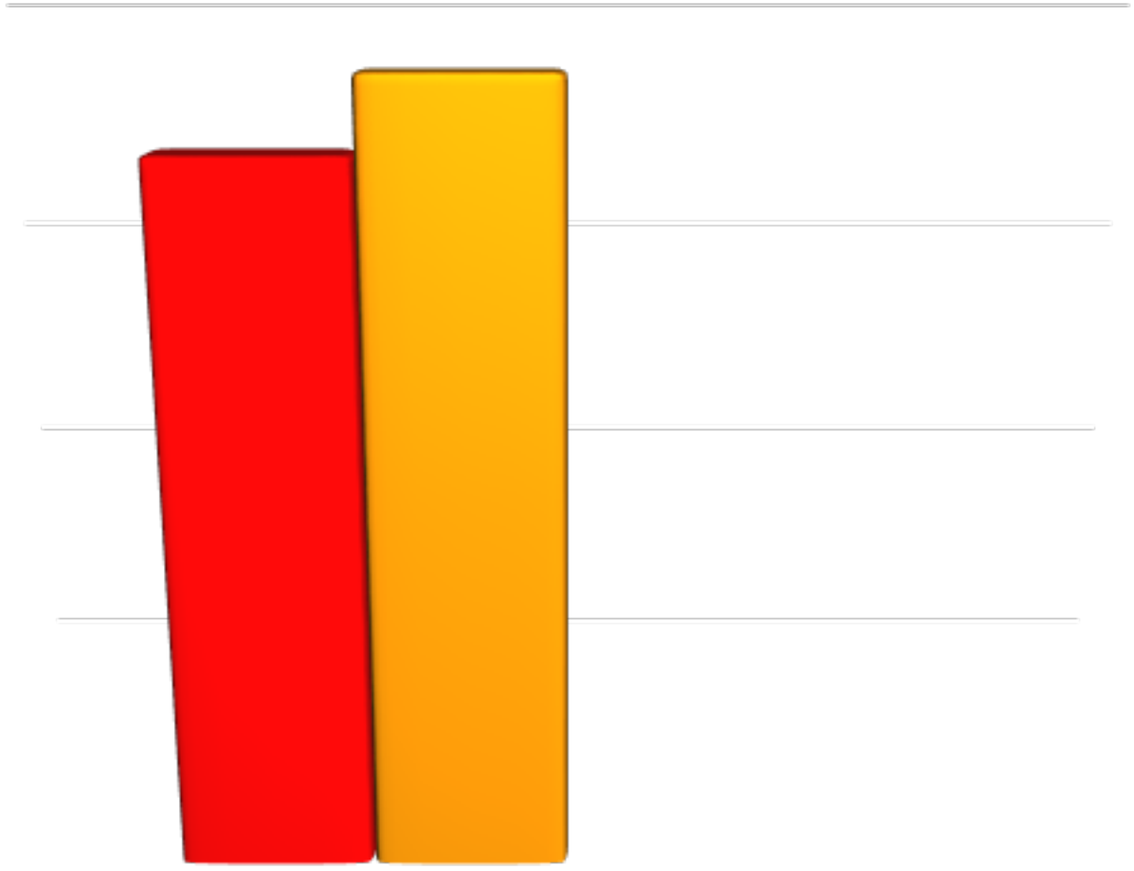
Simultaneous Binocular Distance and Near Visual Acuity

93% of subjects achieved simultaneous 20/25 or better at distance and 20/32 or better at near with distance correction.



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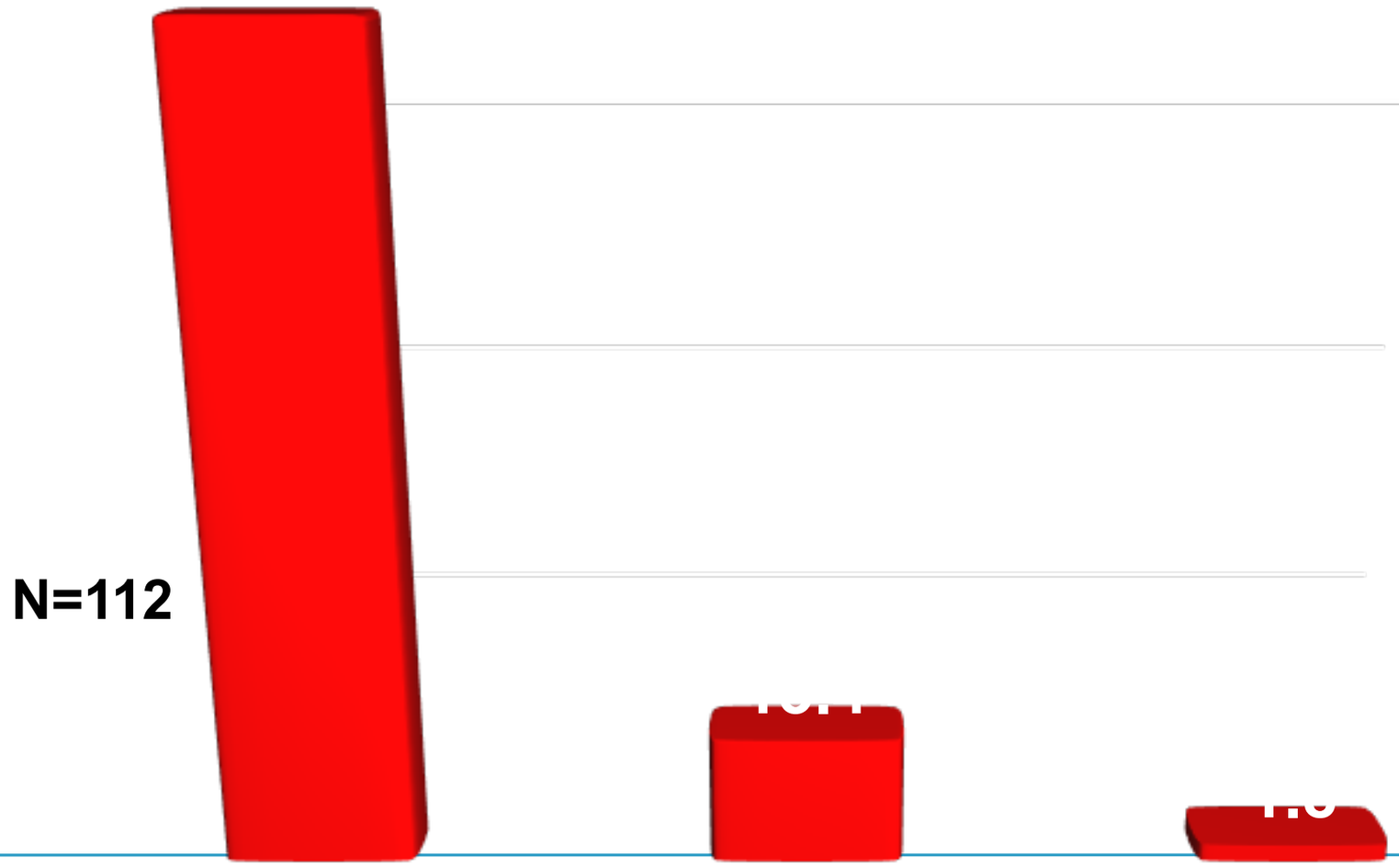
Abbott Medical Optics

Reports of Wearing Glasses

More than 84% of subjects reported never wearing glasses post-implantation.



U.S. FDA Clinical Trials

Summary of Results

- 94.6 % would choose lens again
- 87% were 20/20 or better BCVA
- 94% were 20/32 (~J2) or better at near (with distance correction)

Thank You!

Dr Koziol