



The Structure of the Human Eye

Introduction to the Eye

The Natural Camera

The human eye is one of the most complex and sensitive sense organs. It functions remarkably like a camera, capturing light from the world around us and converting it into images that our brain can understand.

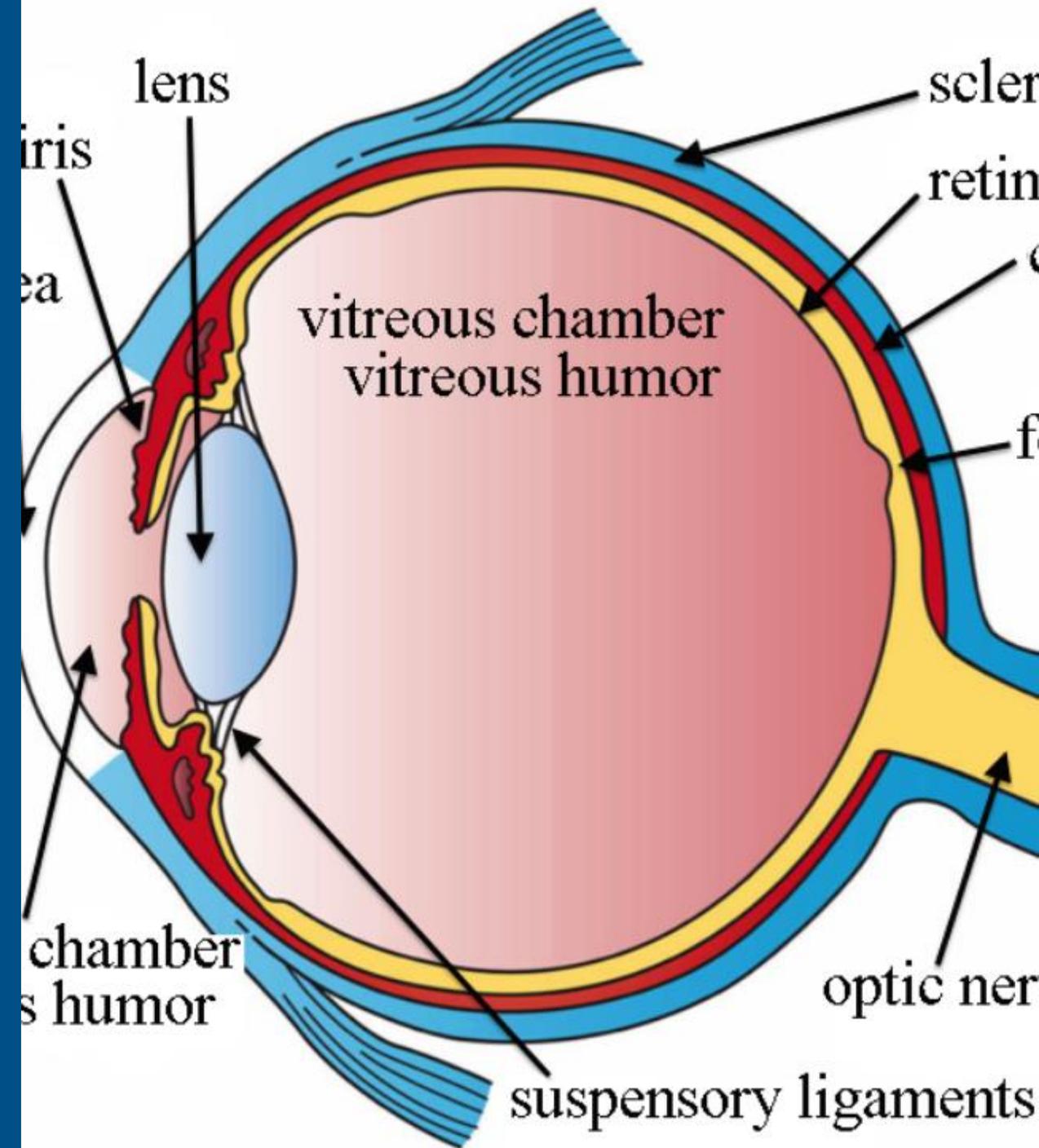
Key Dimensions

The human eye is roughly spherical in shape with a diameter of about 2.3 cm. It is protected within the bony socket of the skull, cushioned by fat, and moved by six distinct muscles.

Three Main Layers

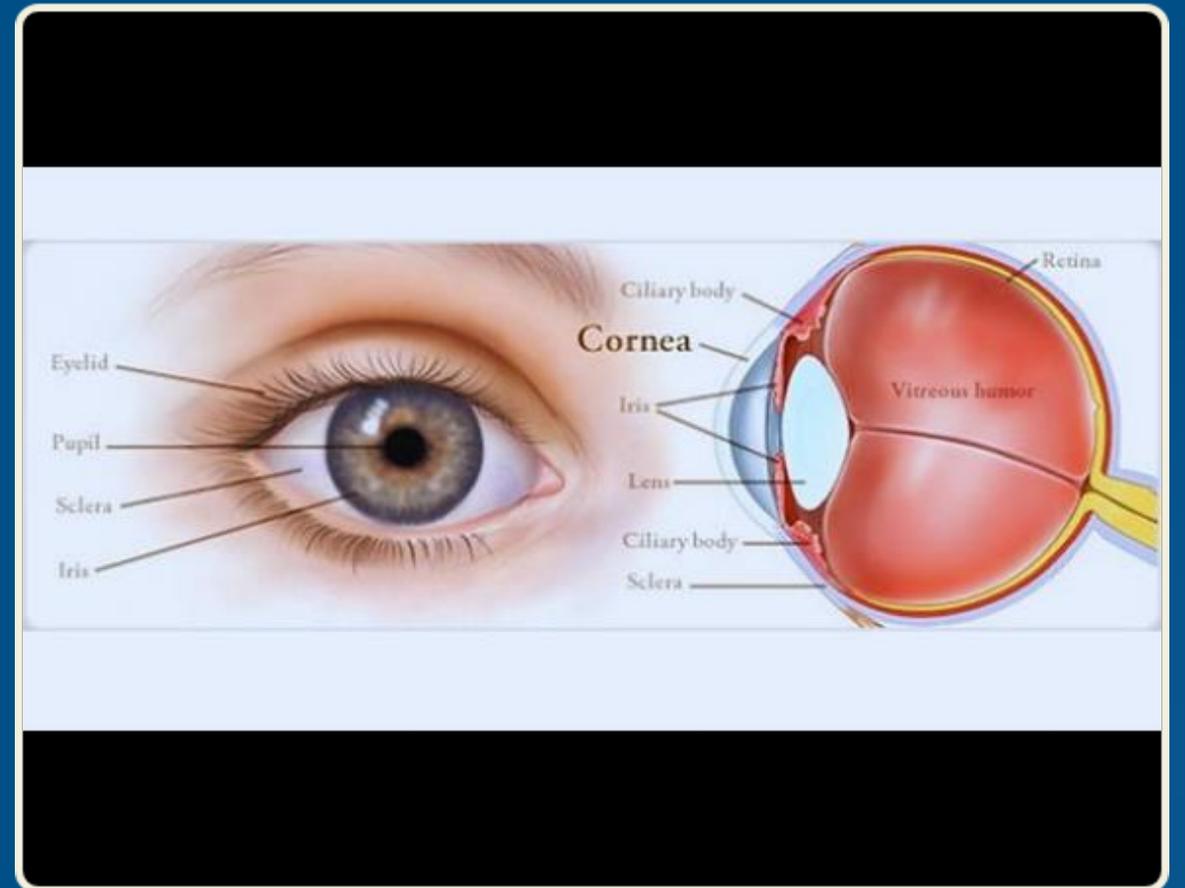
The wall of the eyeball is composed of three concentric layers:

- 1. Fibrous Tunic (Outer):** The tough, protective outer layer comprising the Sclera and Cornea.
- 2. Vascular Tunic (Middle):** The nutritive layer containing blood vessels, comprising the Choroid, Ciliary Body, and Iris.
- 3. Neural Tunic (Inner):** The light-sensitive layer known as the Retina.



1. The Sclera (Outer Layer)

- ✓ The **Sclera** is the tough, opaque, white outer coat of the eye (commonly known as the "white of the eye").
- ✓ **Function:** It maintains the shape of the eyeball and protects the delicate inner structures from mechanical injury.
- ✓ It is composed of dense connective tissue and forms the posterior 5/6th of the outer layer.



2. The Cornea (The Window)

Structure

The cornea is the transparent, anterior part of the eye's outer layer. It bulges outward and covers the iris and pupil. Unlike the sclera, it contains no blood vessels (avascular).

Function

It acts as the primary window for light to enter. Crucially, it provides about **65–75% of the eye's focusing power** by refracting (bending) incoming light rays onto the lens.

3. The Conjunctiva



Location

A thin, transparent mucous membrane that lines the inner surface of the eyelids and covers the visible white part (sclera) of the eye.



Lubrication

It helps lubricate the eye by producing mucus and tears (in small amounts), preventing the eye from drying out.



Protection

It serves as a barrier against dust and microbes. Inflammation of this layer is known as "Conjunctivitis" or Pink Eye.

4. The Iris (Middle Layer)

The **Iris** is the dark, muscular diaphragm located just behind the cornea. It is the visible colored part of the eye.

- ✔ **Pigmentation:** The color of the eye (blue, brown, green) depends on the amount of melanin pigment present in the iris.
- ✔ **Function:** It controls the amount of light entering the eye by adjusting the size of the pupil.

5. The Pupil (The Aperture)

What is it?

The pupil is not a structure itself, but a hole or aperture in the center of the iris. It appears black because no light is reflected back from the inside of the eye.

Mechanism

Bright Light: The iris muscles contract to make the pupil smaller (constriction), reducing light entry.

Dim Light: The iris muscles relax to make the pupil larger (dilation), allowing more light in.

6. The Ciliary Body

The **Ciliary Body** is an extension of the choroid layer located behind the iris.



Ciliary Muscles

These smooth muscles hold the lens in position and modify its shape to focus on objects at different distances.



Suspensory Ligaments

Also called zonules, these are fine fibers that connect the ciliary body to the lens, holding it in place.



Aqueous Humor

The ciliary body secretes the aqueous humor, the clear fluid filling the front of the eye.

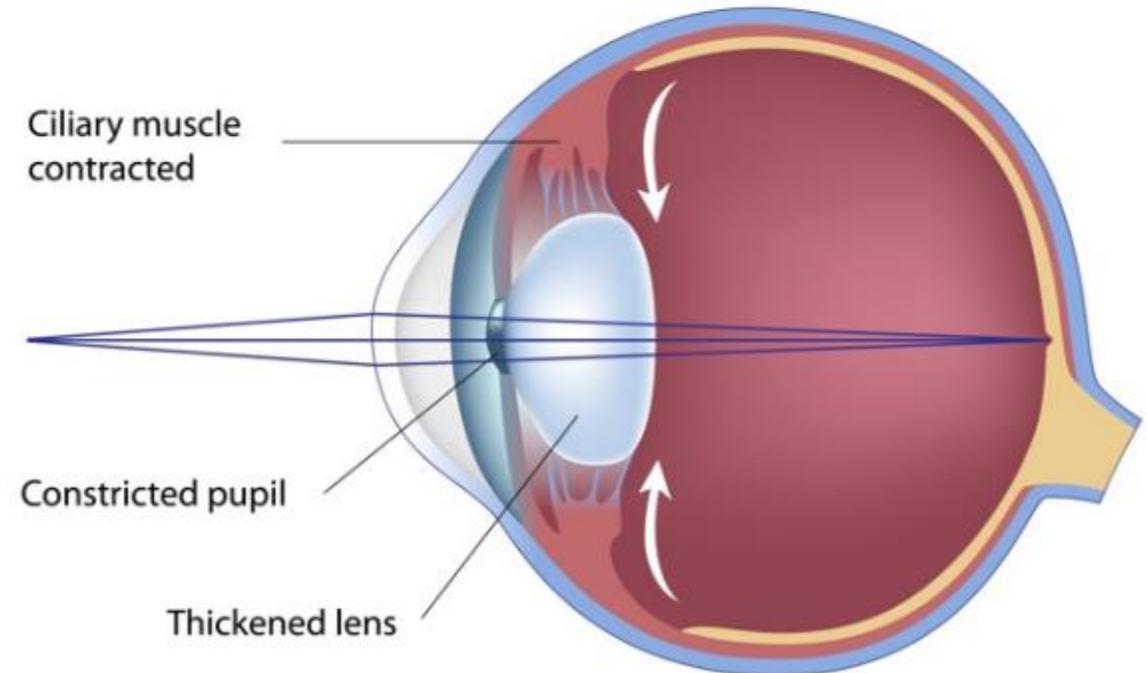
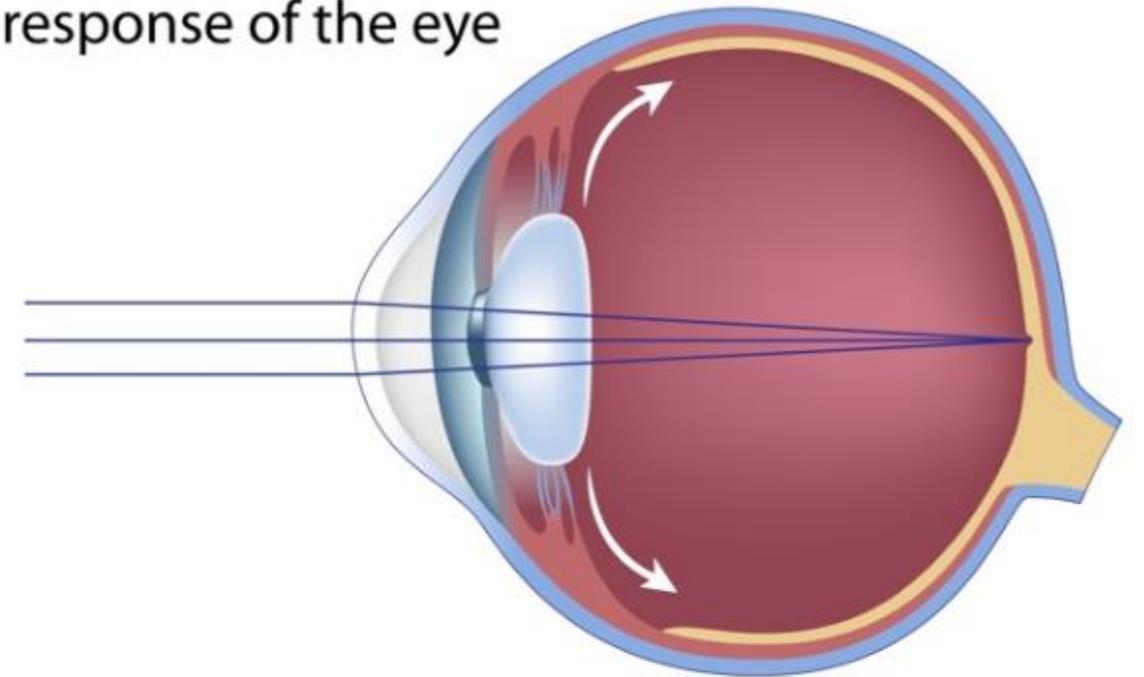
7. The Crystalline Lens

The **Lens** is a transparent, biconvex structure composed of fibrous, jelly-like material.

Location: Located immediately behind the iris and pupil.

Function: Its primary role is fine-focusing. While the cornea does the gross focusing, the lens changes its curvature (accommodation) to focus light precisely on the retina for objects at varying distances.

near response of the eye



8. The Choroid

The Vascular Layer

The **Choroid** is the middle layer of the eye wall, sandwiched between the sclera and retina. It is rich in blood vessels.

Key Functions

- ✔ **Nourishment:** It provides oxygen and nutrients to the outer layers of the retina.
- ✔ **Light Absorption:** It contains dark pigments (melanin) which absorb stray light, preventing internal reflection that could blur vision.

9. Aqueous Humor



Composition

A transparent, watery fluid consisting of 99.9% water and 0.1% nutrients (vitamins, proteins).



Circulation

It fills the anterior chamber (between cornea and iris) and posterior chamber (between iris and lens).



Function

Maintains intraocular pressure (IOP) to keep the eye inflated and nourishes the avascular cornea and lens.

10. Vitreous Humor

The Gel

A clear, colorless, jelly-like substance that fills the large space (vitreous chamber) between the lens and the retina. It comprises about 80% of the eye's volume.

Purpose

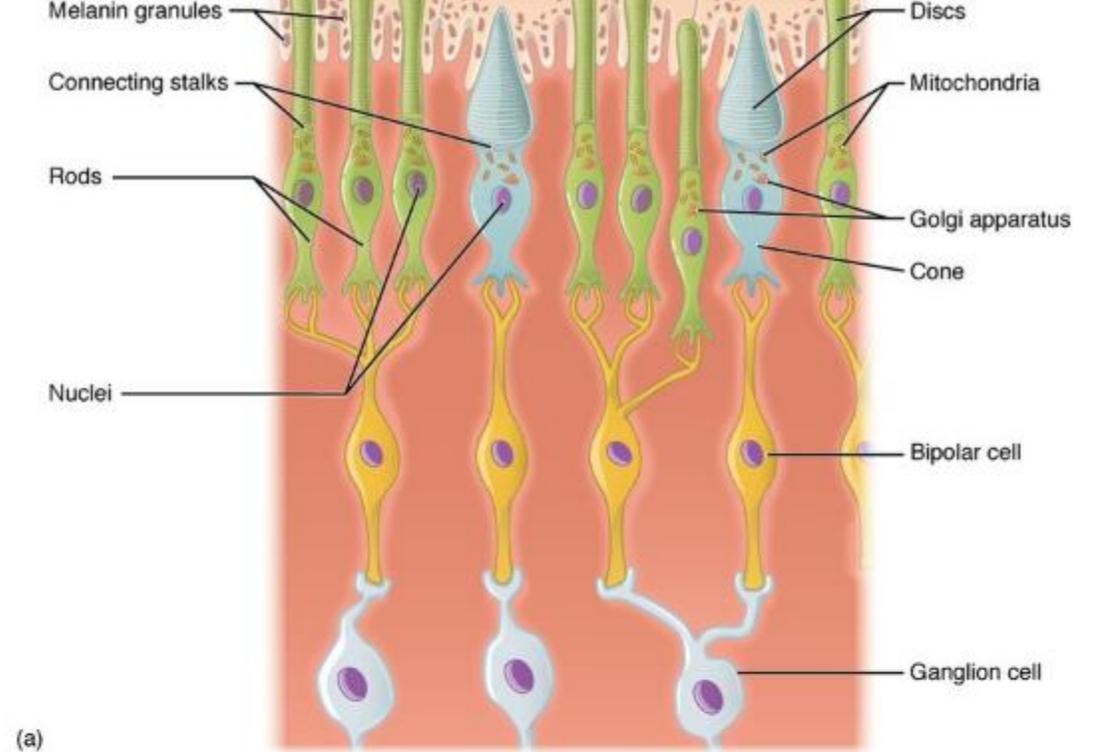
Unlike aqueous humor, it is not replenished. It helps maintain the spherical shape of the eyeball and keeps the delicate retina pressed against the choroid wall.

11. The Retina

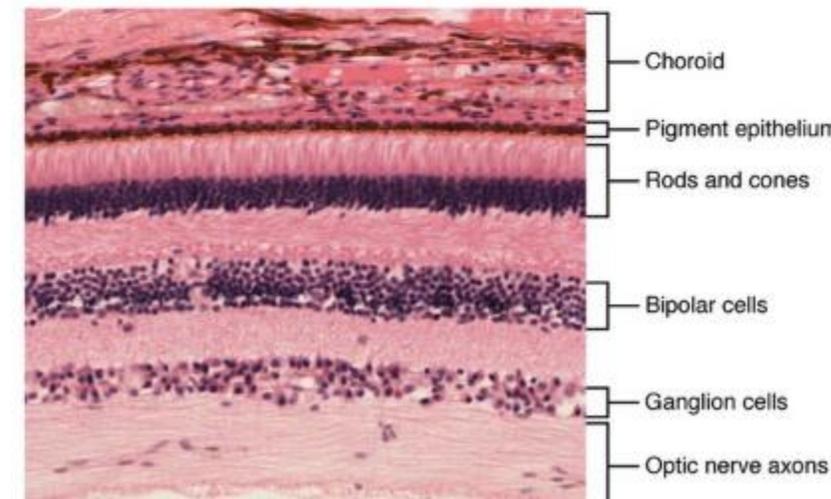
The **Retina** is the innermost, light-sensitive layer of the eye. It acts like the film in a camera or the sensor in a digital camera.

Structure: It is a delicate membrane containing millions of photosensitive cells (photoreceptors) and nerve fibers.

Function: It converts light energy into electrical signals (nerve impulses) that are sent to the brain via the optic nerve.



(a)



Retina: Pigment Epithelium

The Outer Layer

This is a single layer of hexagonal cells packed with melanin granules, situated right next to the choroid.

It absorbs excess light to prevent scattering and nourishes the photoreceptor cells lying above it.

Why is it black?

Similar to the black interior of a camera body, this dark layer ensures that image formation is crisp by stopping light from bouncing around inside the eye.

Photoreceptors: Rod Cells



Night Vision

Rods are extremely sensitive to light and enable us to see in dim light (scotopic vision).



No Color

They do not detect color, which is why we only see in shades of gray in the dark.



Abundance

There are about 120 million rod cells in the human retina, mostly concentrated in the peripheral areas.

Photoreceptors: Cone Cells



Day Vision

Cones function best in bright light (photopic vision) and are responsible for sharp, detailed vision.



Color Vision

They come in three types (Red, Green, Blue sensitive) allowing us to perceive millions of colors.



Location

There are about 6 million cone cells, concentrated densely in the center of the retina (macula).

Comparison: Rods vs Cones

Feature	Rods	Cones
Sensitivity	High (Dim light)	Low (Bright light)
Color Vision	No (Monochromatic)	Yes (Trichromatic)
Acuity (Sharpness)	Low	High
Pigment	Rhodopsin	Iodopsin
Number	~120 Million	~6 Million

Macula and Fovea Centralis

Yellow Spot (Macula)

The Macula Lutea is a small, yellowish oval spot near the center of the retina. It is responsible for central, high-resolution color vision.

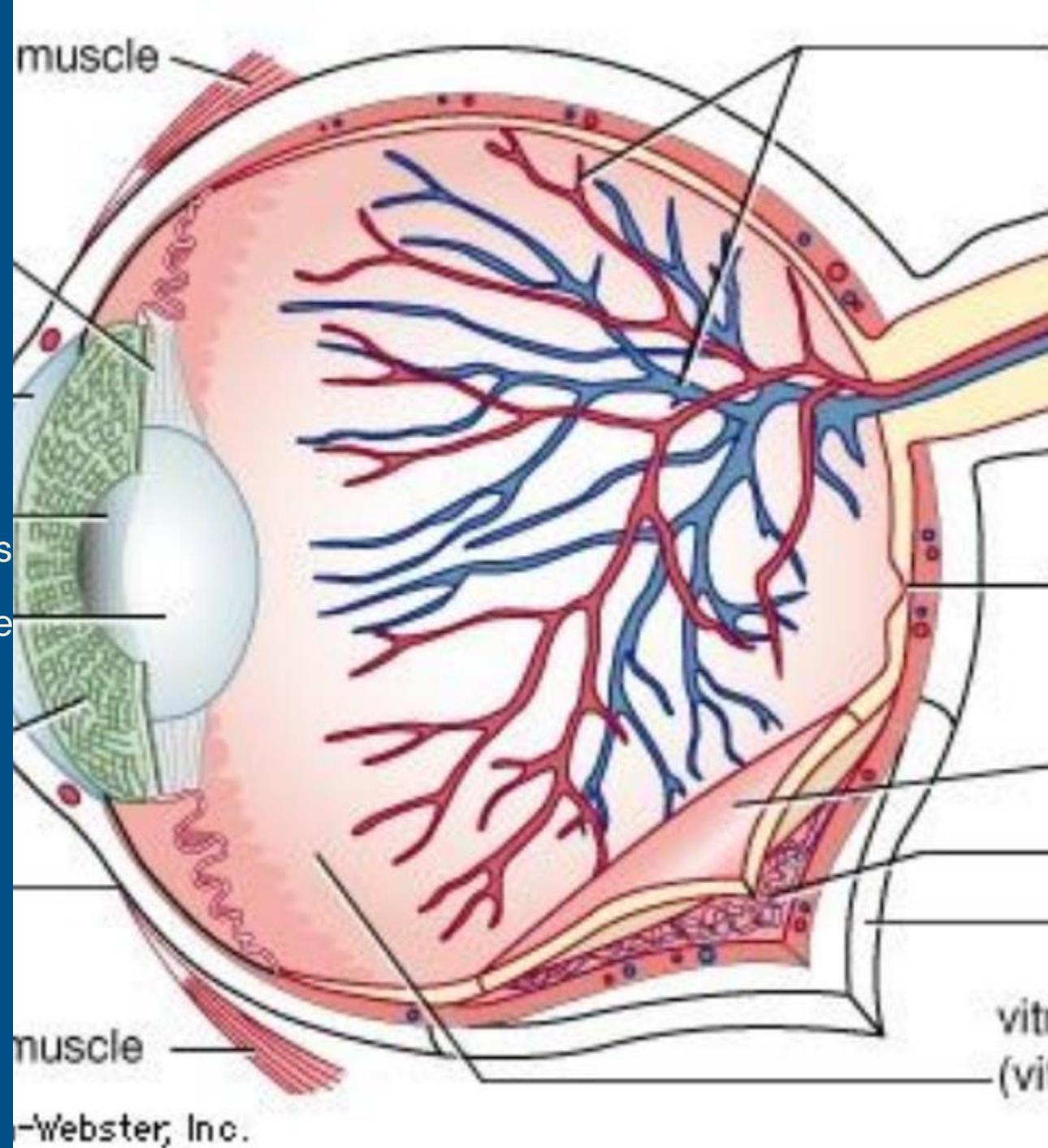
Fovea Centralis

A tiny depression in the center of the macula. It contains **only cone cells** (no rods). This is the point of sharpest vision where the image falls when you look directly at something.

Optic Nerve & Blind Spot

Optic Nerve: A bundle of over 1 million nerve fibers that carries visual messages from the retina to the brain.

Blind Spot (Optic Disc): The point where the optic nerve exits the eye. There are **no photoreceptors** (rods or cones) here, so any light falling on this spot is not detected.

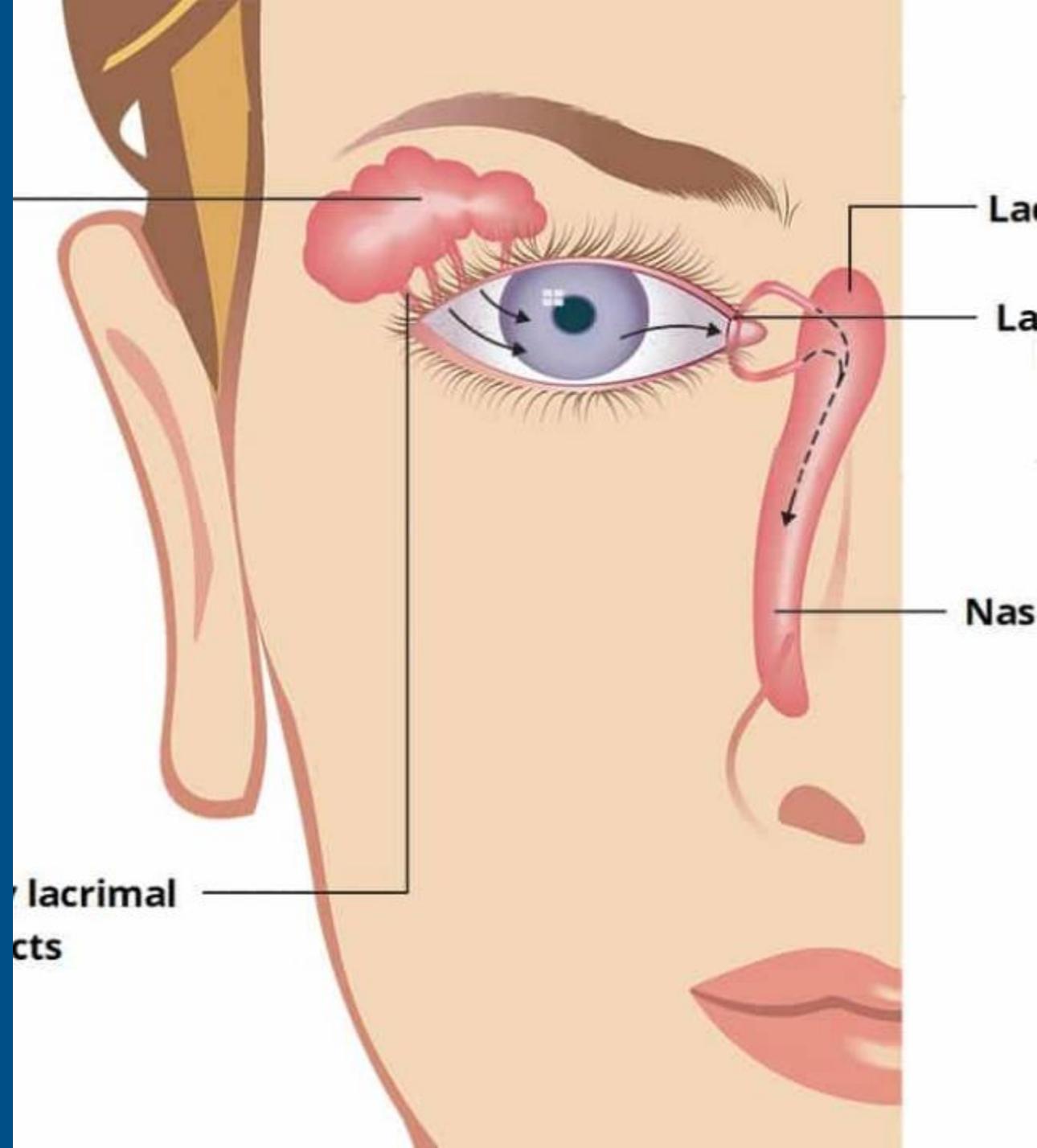


The Lacrimal Apparatus

This system produces and drains tears.

Lacrimal Gland: Located above the outer corner of the eye, it secretes tears.

Function of Tears: They wash away foreign particles, kill bacteria (via enzyme Lysozyme), and keep the cornea moist and transparent.

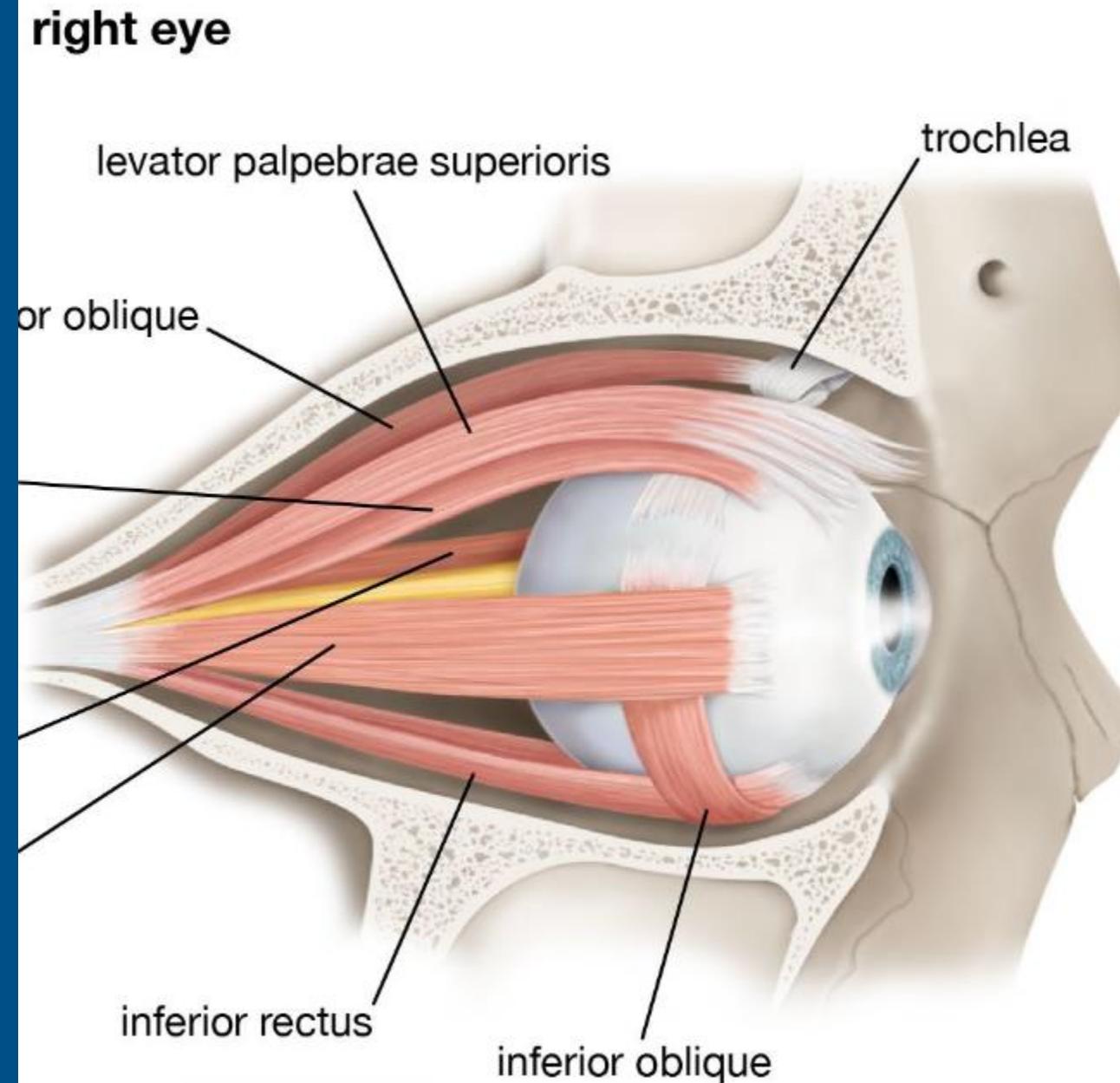


Eye Movement

Six skeletal muscles attach to the outside of the sclera to control eye movement:

- **4 Rectus Muscles:** Superior, Inferior, Medial, Lateral (move eye up, down, left, right).
- **2 Oblique Muscles:** Superior and Inferior (rotate the eye).

These muscles work in perfect coordination to track objects.



Physiology of Vision

How do we actually see? The process involves four key steps:

1. Refraction

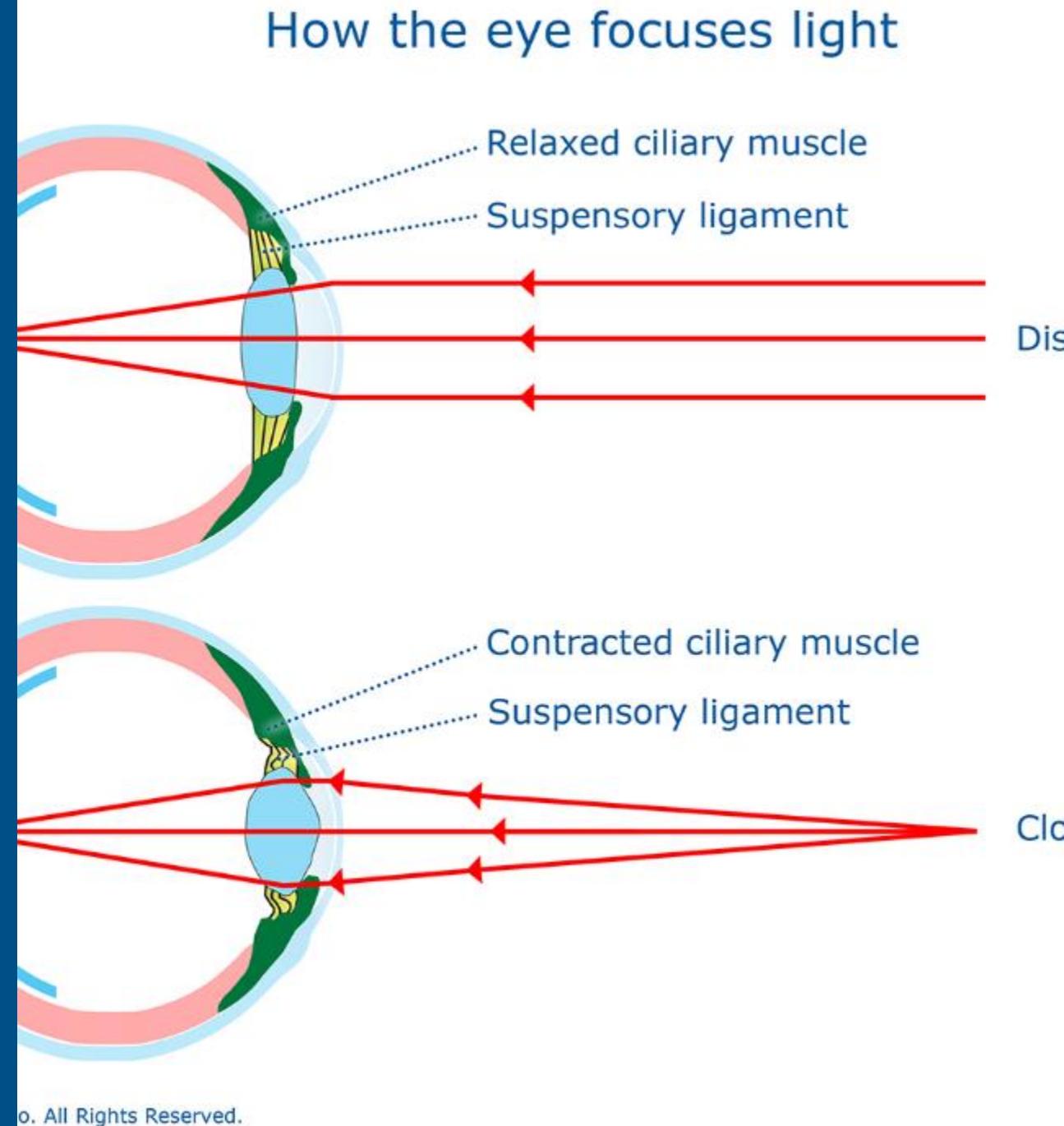
2. Accommodation

3. Image Formation

4. Brain Processing

Step 1: Refraction of Light

When light rays from an object enter the eye, they pass through different media: Cornea → Aqueous Humor → Lens → Vitreous Humor. Since these media have different densities, the light bends (refracts). **The Cornea** does most of the bending, while the lens fine-tunes it.



Step 2: Image Formation

The Image on Retina

The convex lens system of the eye converges light rays to focus them on the retina. The image formed on the retina is:

- ✓ **Real**
- ✓ **Inverted** (Upside down)
- ✓ **Diminished** (Smaller than object)

Why don't we see upside down?

Even though the image is inverted, the brain processes the raw data and "flips" it in our perception so we see the world upright.

Step 3: Transduction

Transduction is the conversion of light energy into electrical signals.



Activation

Light hits the visual pigments (Rhodopsin/Iodopsin) in rods and cones, causing a chemical change (Bleaching).



Potential

This chemical change generates an electrical potential difference in the cell membrane.

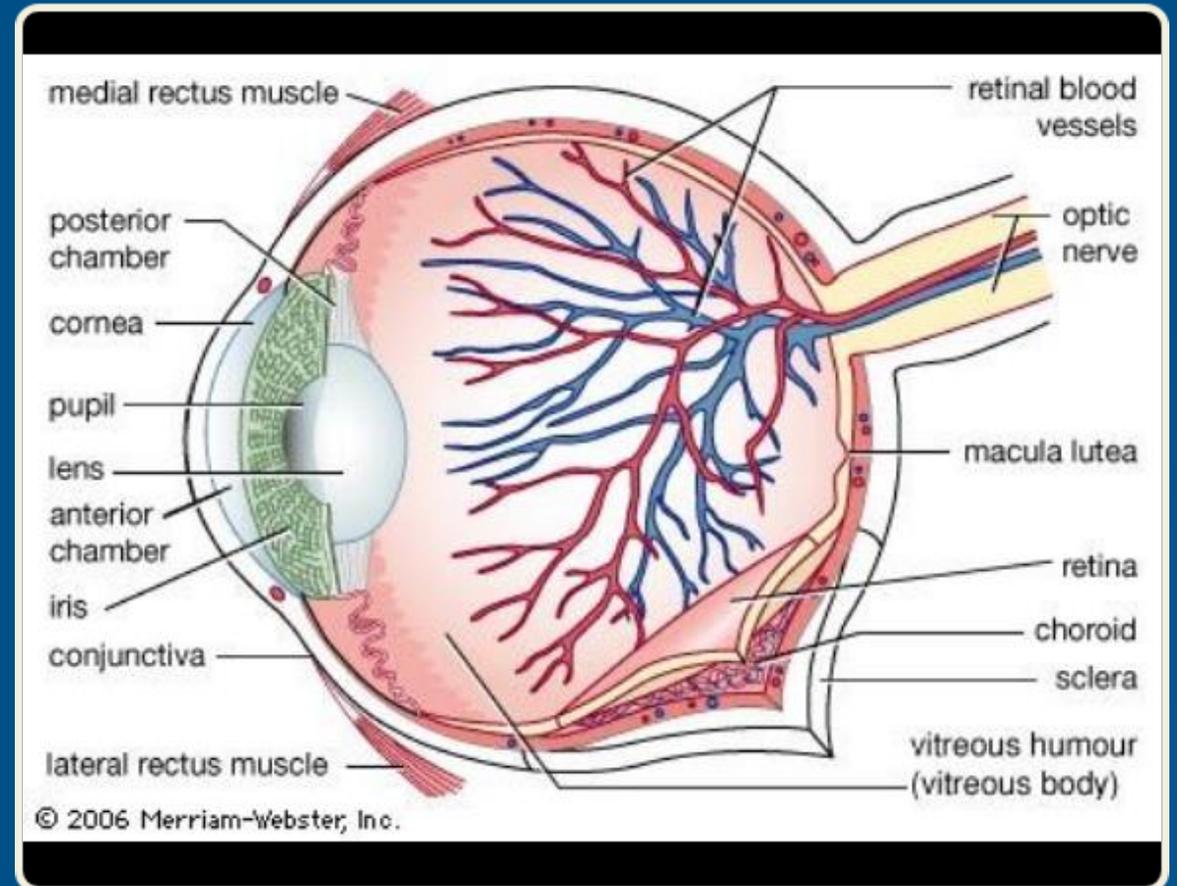


Transmission

Nerve impulses are generated and sent to Bipolar cells, then Ganglion cells, and finally the Optic Nerve.

Step 4: Brain Processing

- ✓ The optic nerves from both eyes meet at the **Optic Chiasm**, where some fibers cross.
- ✓ Signals travel to the **Visual Cortex** in the occipital lobe (back of the brain).
- ✓ The brain interprets these signals as shape, color, depth, and motion, constructing the final image we "see".



What is Accommodation?

"The ability of the eye lens to adjust its focal length to focus on objects at varying distances is called Accommodation."

Distant Objects

Parallel rays need less bending.

Near Objects

Diverging rays need more bending.

How Accommodation Works

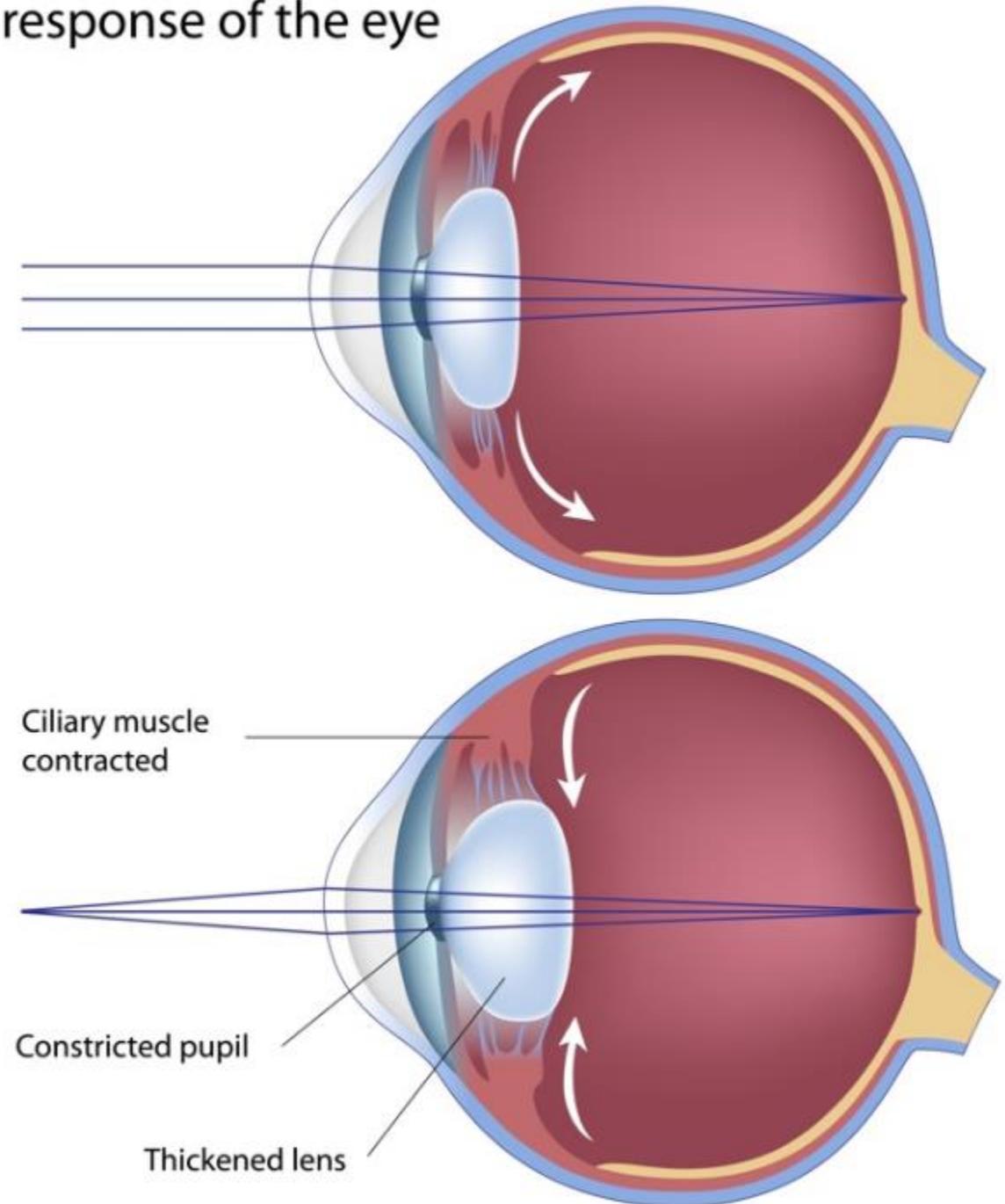
Viewing Distant Objects:

Ciliary muscles relax → Ligaments tighten → Lens becomes **thin** (focal length increases).

Viewing Near Objects:

Ciliary muscles contract → Ligaments relax → Lens becomes **thick/round** (focal length decreases).

near response of the eye



Binocular Vision



Two Eyes

Humans have two eyes located at the front of the head, providing overlapping fields of view.



Stereopsis

Since eyes are spaced apart, each sees a slightly different angle. The brain combines these to create 3D depth perception.



Benefits

This allows us to judge distance, speed, and depth accurately—crucial for catching a ball or driving.

Defects of Vision

Sometimes the eye loses its power of accommodation or the eyeball shape changes, leading to refractive errors.

Myopia

Hypermetropia

Presbyopia

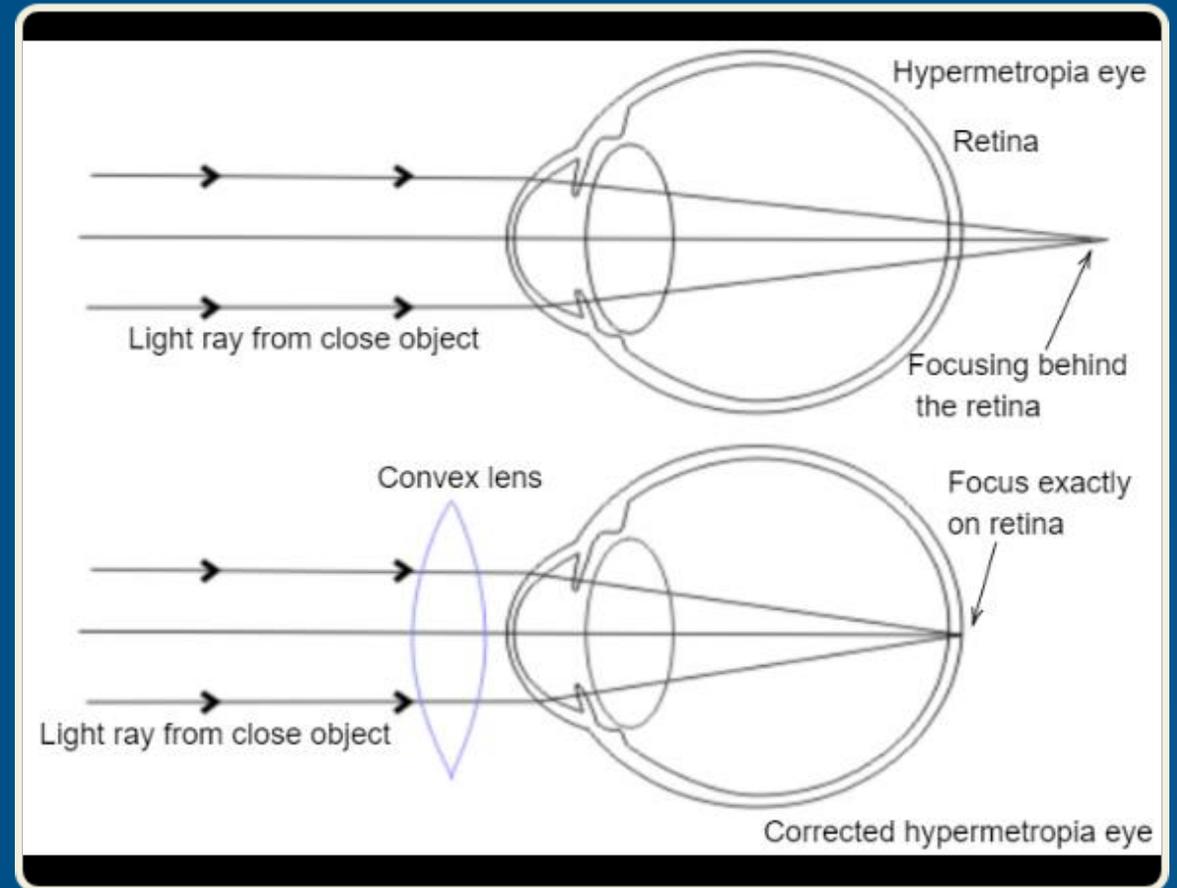
Myopia (Near-sightedness)

Definition: A person can see near objects clearly but distant objects appear blurry.

Causes:

- ✓ Excessive curvature of the eye lens (too much converging power).
- ✓ Elongation of the eyeball.

Result: Image forms **in front** of the retina.



Correction of Myopia

The Lens Used

Corrected by using a **Concave Lens** of suitable power.

How it works

A concave lens diverges the incoming light rays before they enter the eye. This moves the image focal point back onto the retina.

$$P = -\frac{1}{f}$$

(Power is negative)

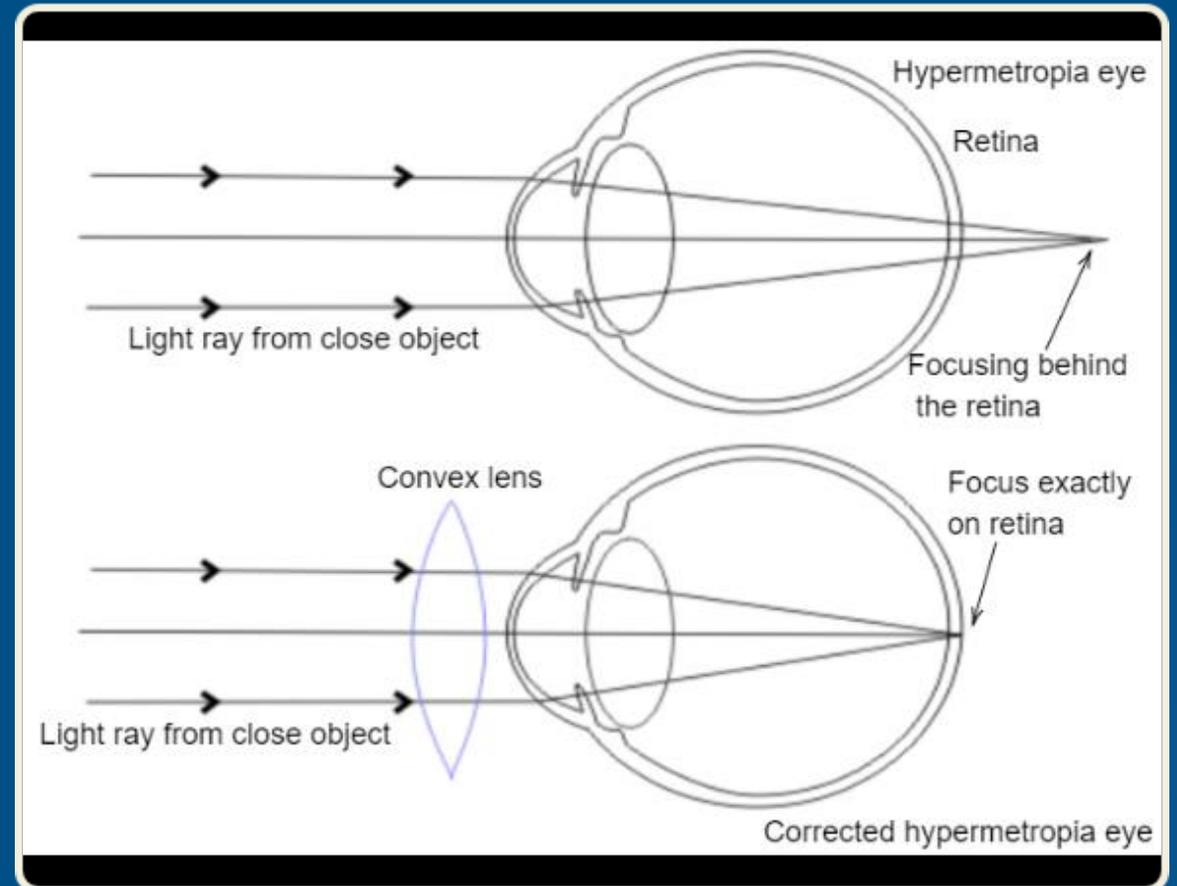
Hypermetropia

Definition: A person can see distant objects clearly but near objects appear blurry.

Causes:

- ✓ Focal length of lens is too long (weak converging power).
- ✓ Eyeball has become too small.

Result: Image forms **behind** the retina.



Correction of Hypermetropia

The Lens Used

Corrected by using a **Convex Lens** of suitable power.

How it works

A convex lens provides additional converging power, bending light rays inwards before they enter the eye, bringing the image forward onto the retina.

$$P = + \frac{1}{f}$$

(Power is positive)

Presbyopia (Old Age Sight)



The Cause

With aging, the ciliary muscles weaken and the crystalline lens loses its flexibility (elasticity).



The Effect

The eye loses its power of accommodation. The near point recedes, making reading difficult.



Correction

Often requires **Bifocal lenses**: Upper part for distant vision (concave) and lower part for reading (convex).

Astigmatism

Definition: Blurred vision at all distances due to an irregular shape of the cornea or lens.

The Shape: Instead of being spherical (like a basketball), the cornea is shaped like a football (toric).

Correction: Corrected using **Cylindrical Lenses** which have different focal powers in different meridians.

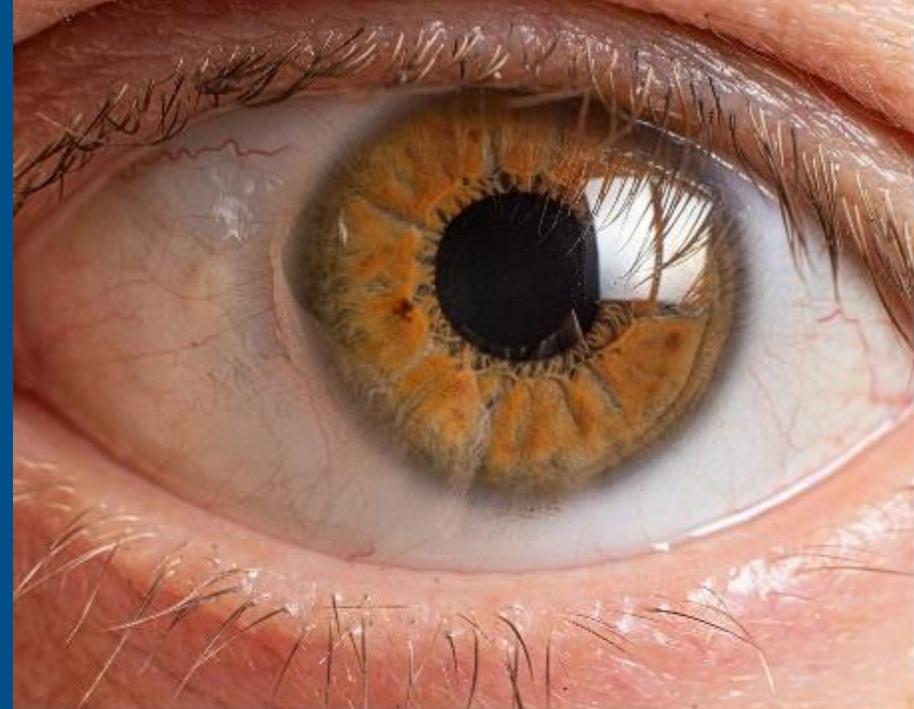


Cataract

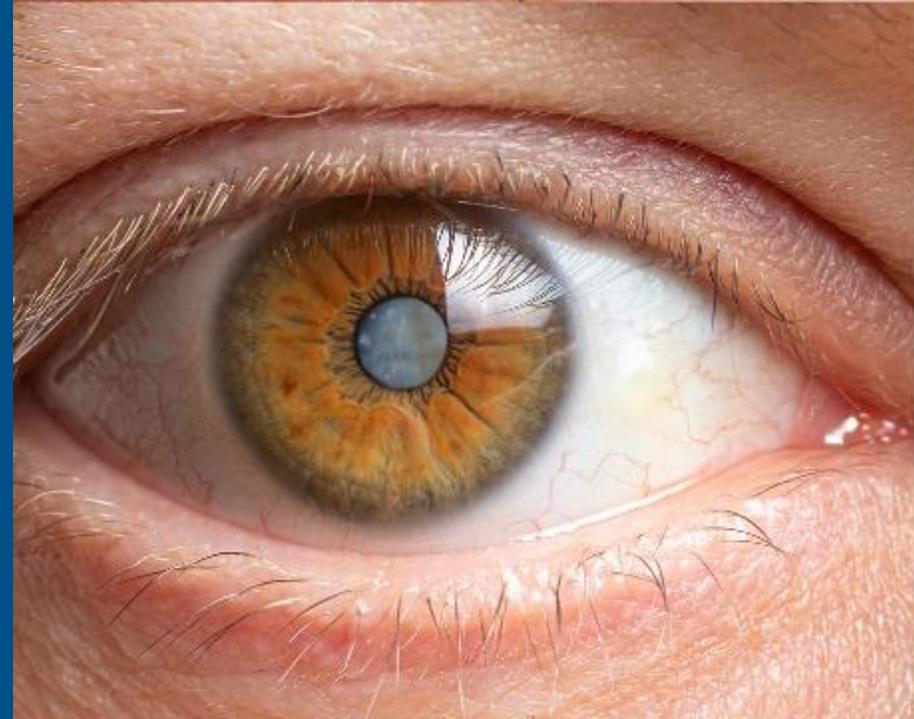
Definition: A medical condition where the crystalline lens becomes milky and cloudy.

Effect: This blocks light from reaching the retina, causing partial or complete vision loss.

Treatment: It cannot be corrected by glasses. It requires **surgery** to remove the cloudy lens and replace it with an artificial Intraocular Lens (IOL).



Normal
Eye

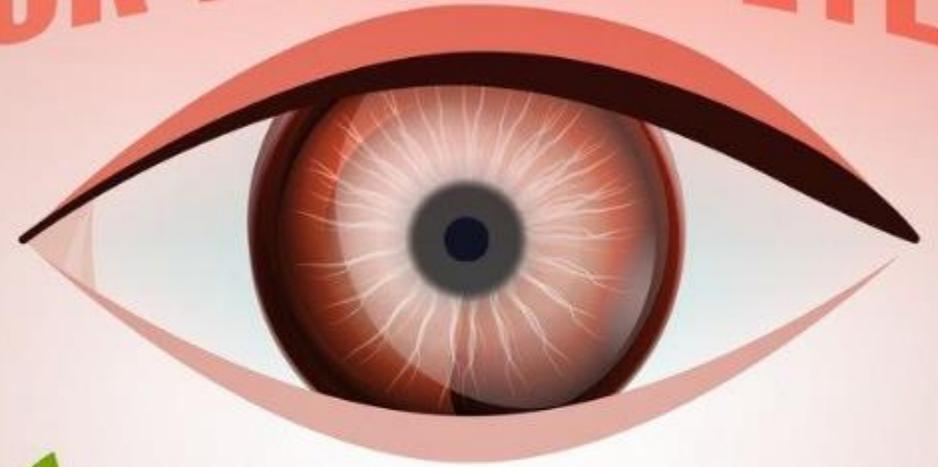


Cataract

Caring for Your Eyes

- **Diet:** Eat foods rich in Vitamin A (carrots, spinach, milk) to prevent night blindness.
- **Lighting:** Do not read in very dim light or direct glaring light.
- **Screen Time:** Follow the 20-20-20 rule: Every 20 mins, look 20 feet away for 20 seconds.
- **Protection:** Wear sunglasses to protect from UV rays and wash eyes with clean water.

12 BEST FOODS FOR HEALTHY EYES



ALMONDS



ORANGES



CARROTS



FISH



DAIRY



BRUSSELS SPROUTS

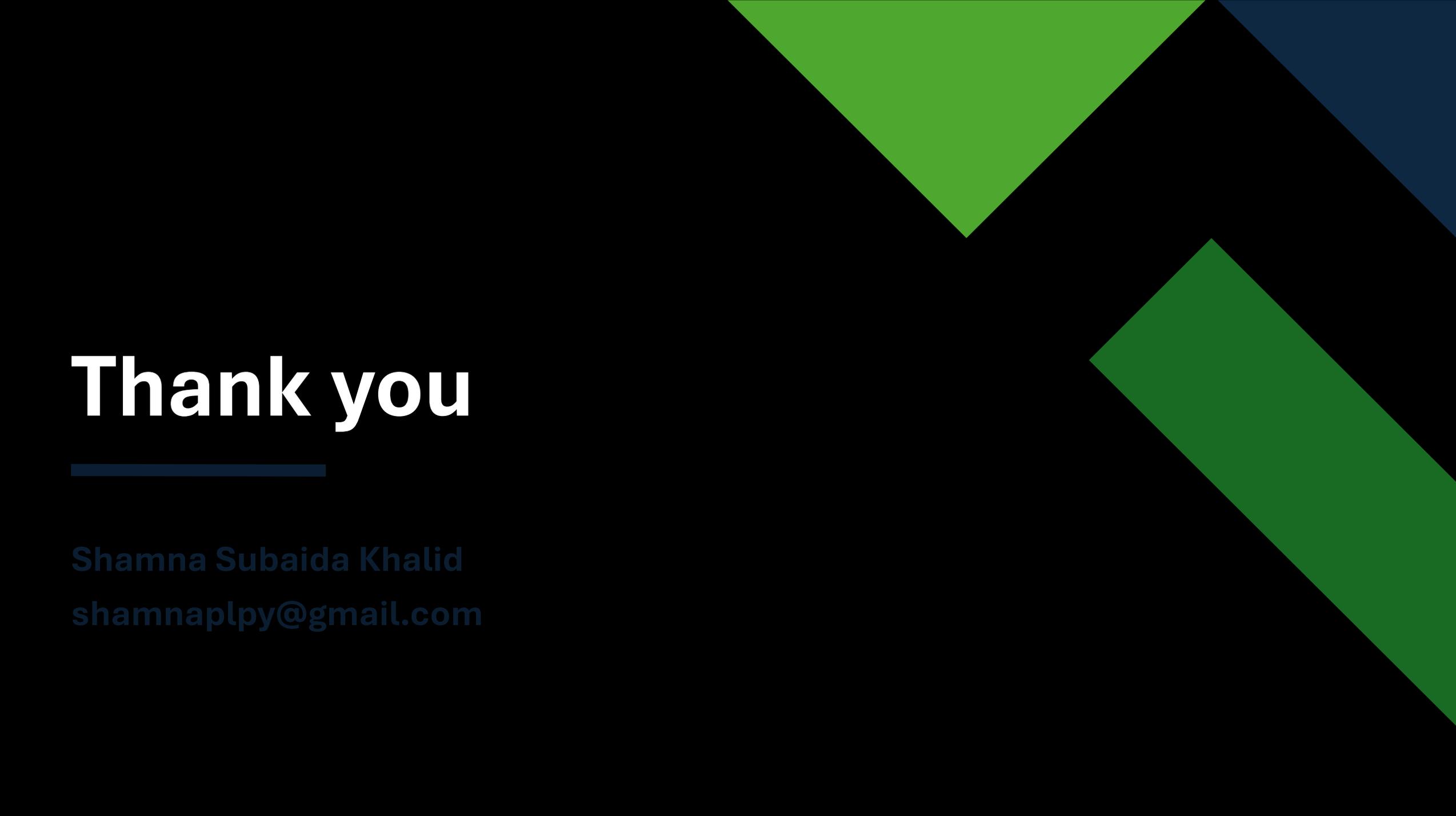


RED PEPPERS



KALE





Thank you

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