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EGYPT

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Constructing Schematic Eye Requirements, Steps and the Obtained clinical values

A Camel - eye model

欧玛尔

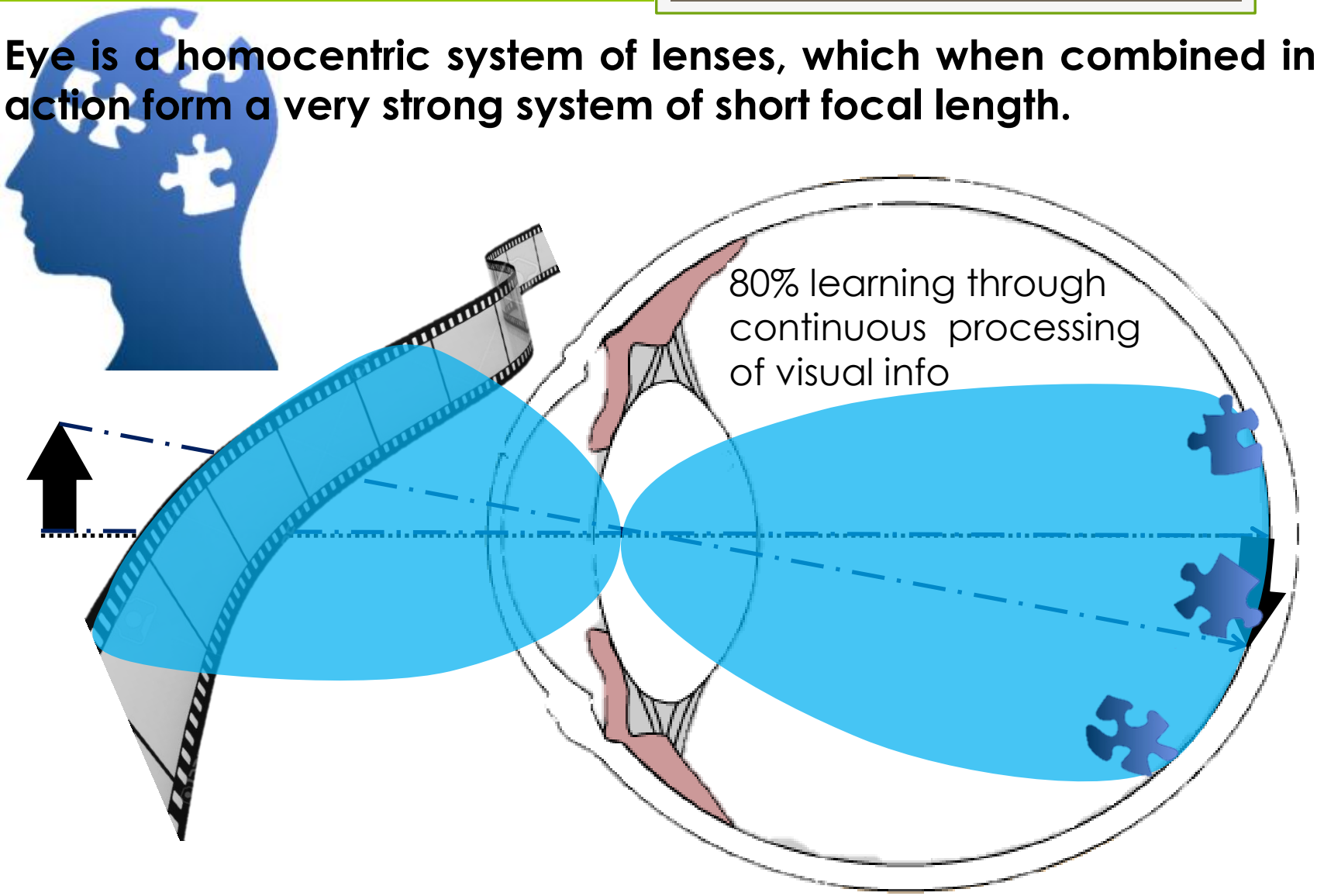
Points to be Discussed

1	Eye vs "*Schematic eye*", models of Schematic eye
2	Benefits/Values of schematic eye (Social/Clinical)
3	Theory behind the Schematic eye
4	Science branches involved and their interaction.
5	What is the required data?
6	Steps: 1 (a, b& c), 2 & 3
7	Interpretations of obtained results
8	Questions?

Introduction

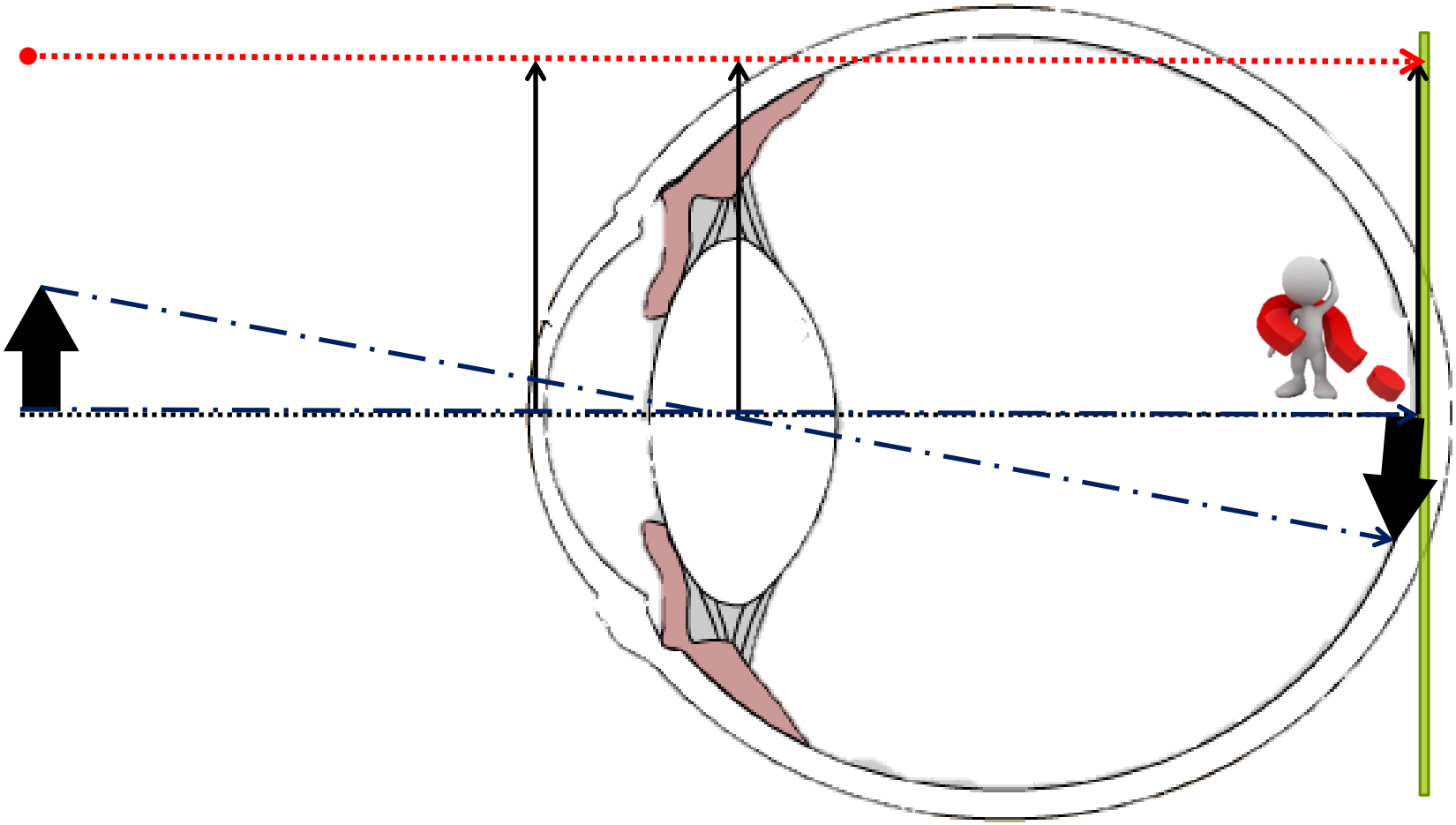
The eye?

Eye is a homocentric system of lenses, which when combined in action form a very strong system of short focal length.



Introduction

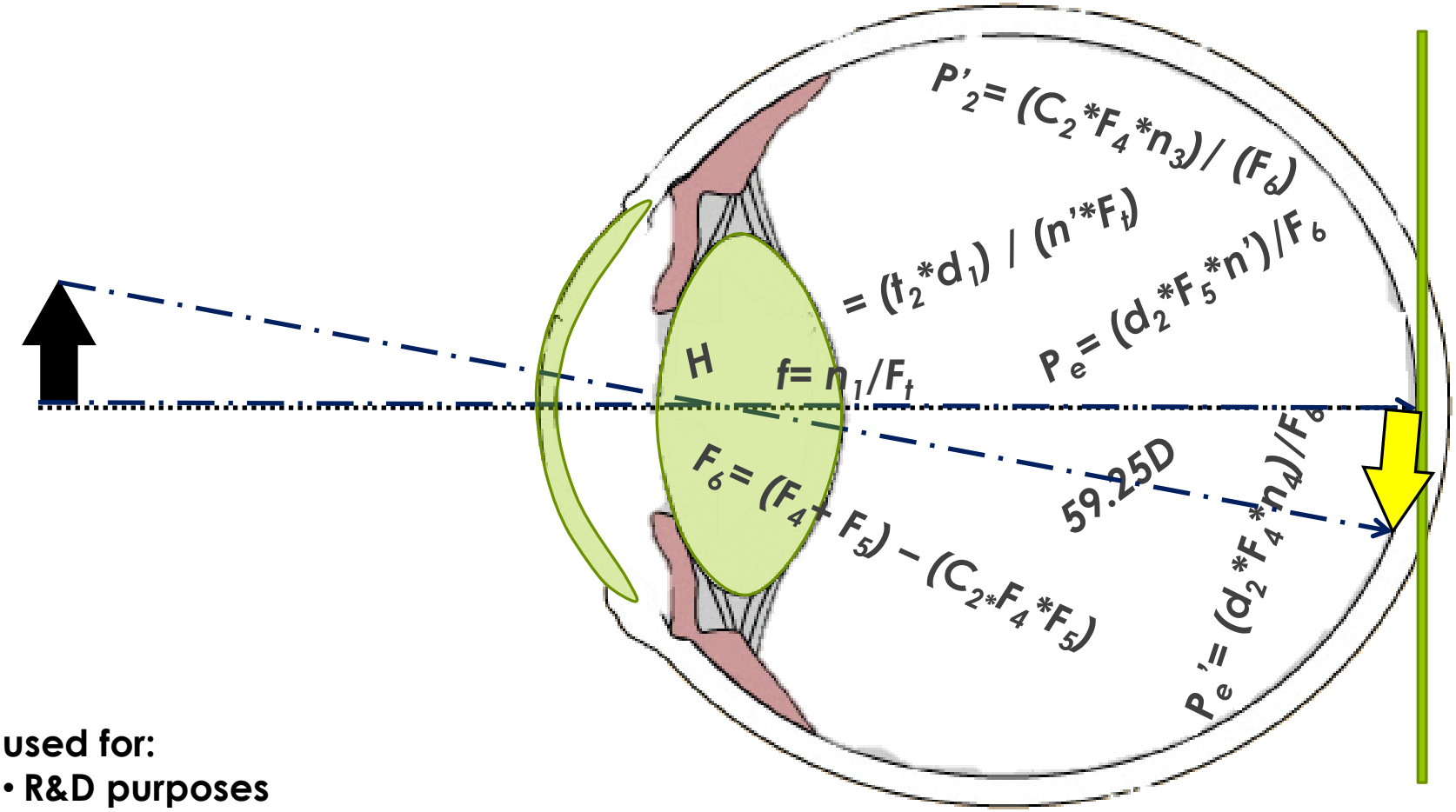
Schematic eye



Introduction

Schematic eye

A schematic eye is a self-consistent mathematical model that represents the basic optical features of the real eye.



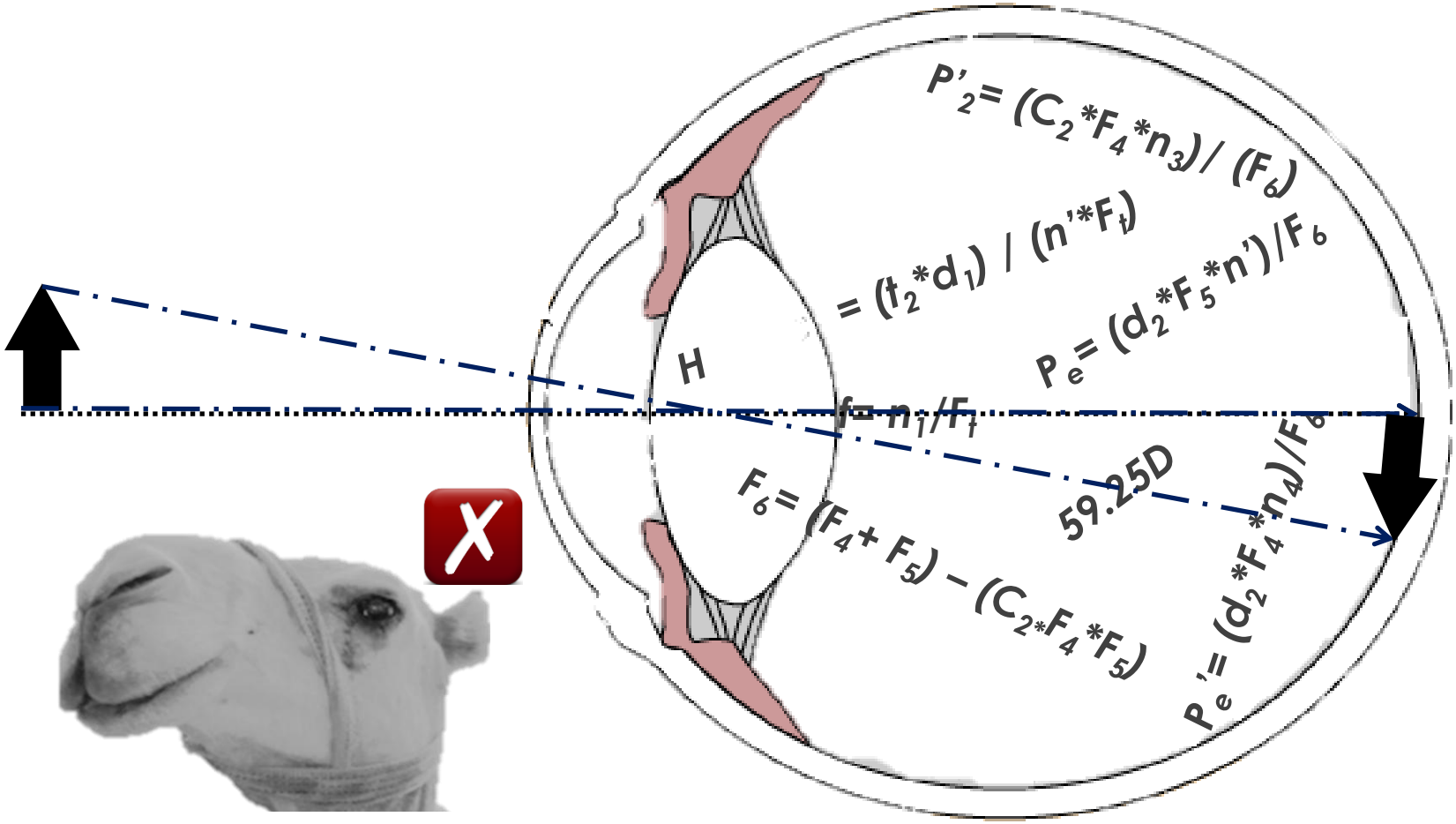
used for:

- **R&D purposes**
- **Describe various optical characteristics of living eyes**

Introduction

Models of Schematic eye?

Schematic eyes have been designed for human, cow, horse, sheep, pig, dog, rabbit and rat/mice



Introduction

Data on camel eyes!!!

Camels are not an easy to handle animals nevertheless to pass an ophthalmological test.

The difficulty in quieting this animal and the expensiveness of the ophthalmological instruments both have contributed to have few publications on it's eye and it's ocular visual characteristics.

TOO many
QUESTIONS
VERY little
ANSWERS

Sedation was achieved by IV injection
0.2 mg/Kg Bomazine 10%,

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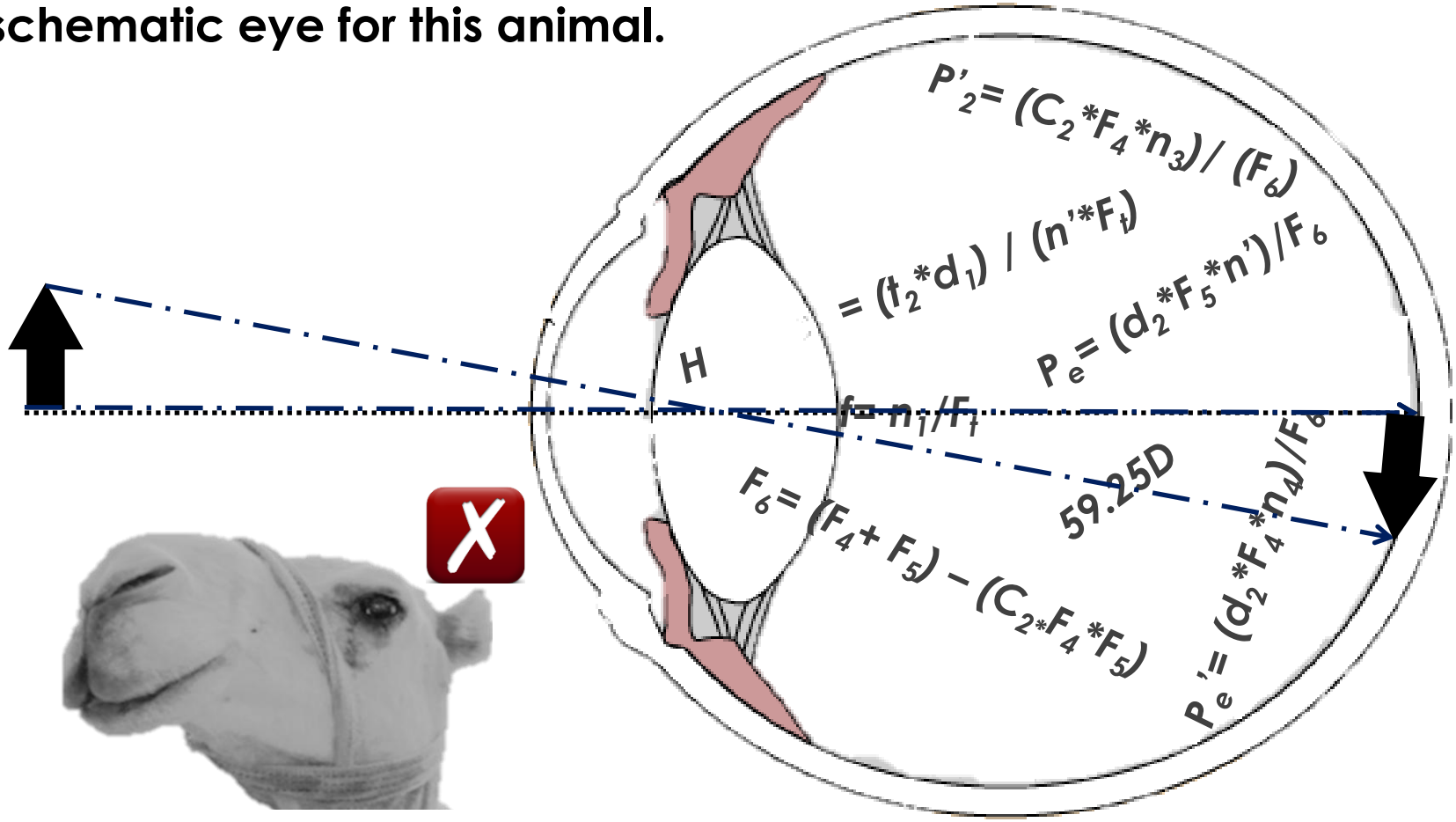
Introduction

Values of Schematic eye?

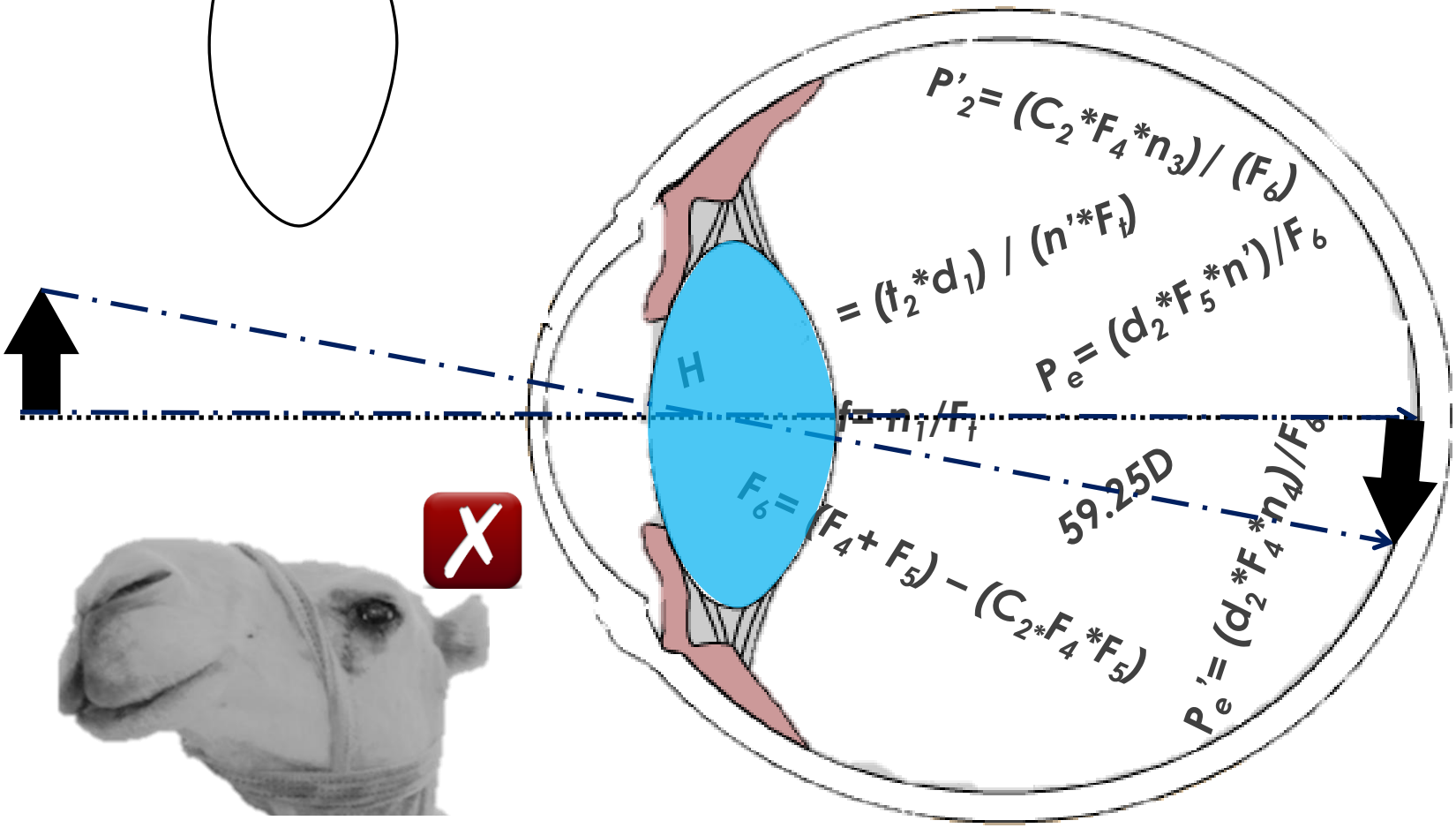
Knowledge of the dimensions and ratios of the optical components of the camel eye provides a resource for the theoretical study of its visual capability and drawing up a schematic eye for this animal.



Introduction

Values of Schematic eye? Clinical

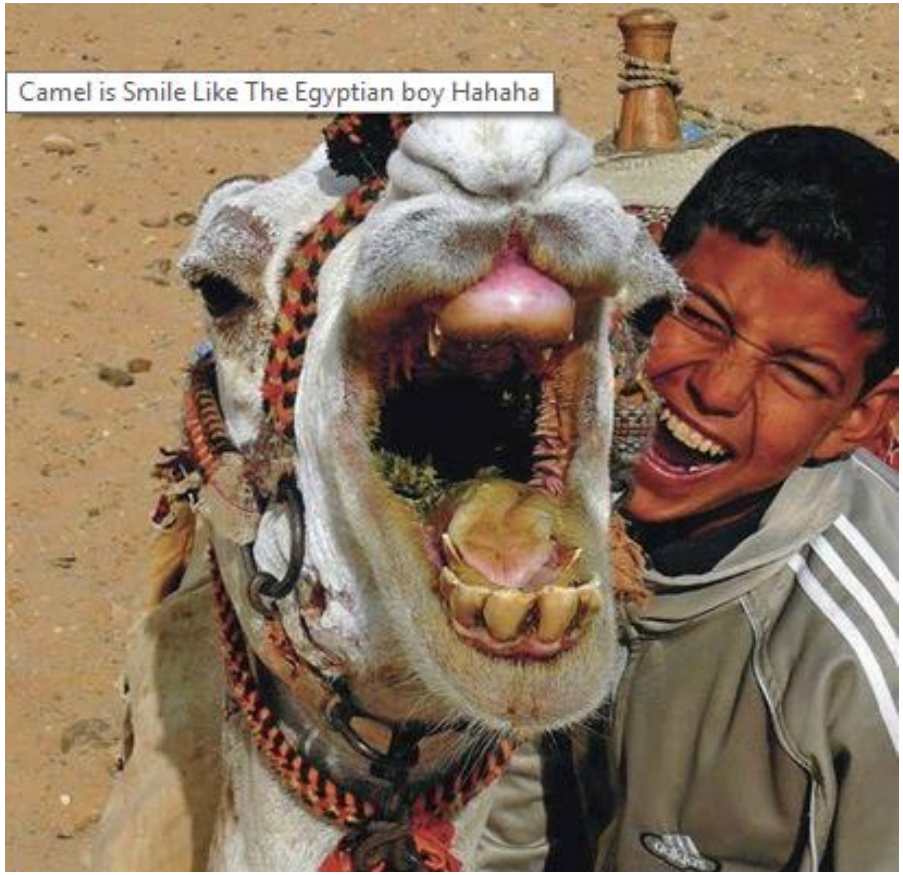
It also allows the calculations of IOL dioptric power to be deployed in eyes of animals that have undergone cataract surgery to e emmetropia



Introduction

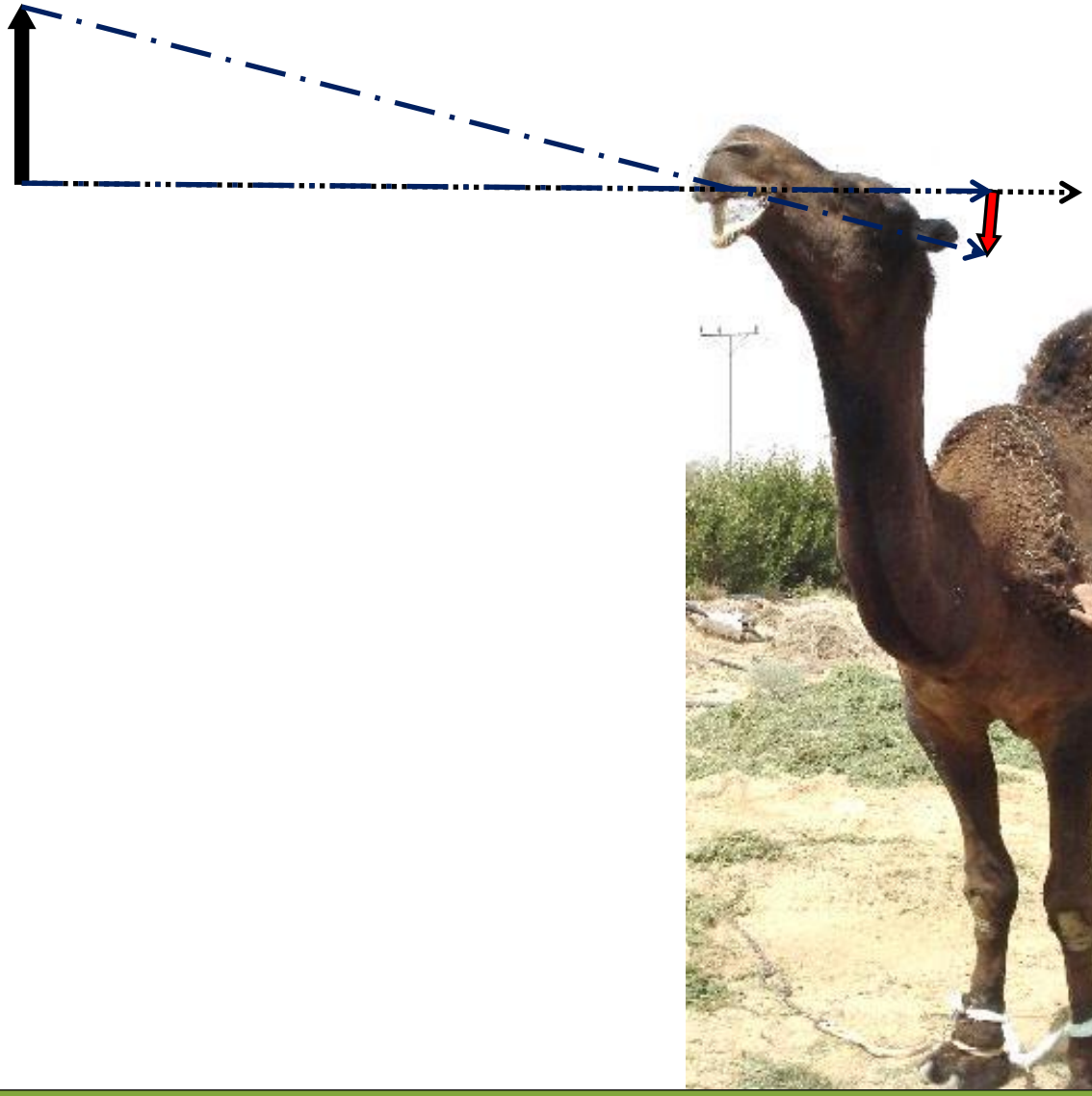
Values of Schematic eye? Social

1- Camel sees small things too big, it's easier to take control of it by young children than older men *(RIM)*.



Values of Schematic eye? Social

2- Camels are *(Far-sighting)*, capable of seeing distant object



Introduction

Values of Schematic eye? Social

3- Susceptible for Envy (the evil-eye) and in the Arab world camels are considered as a Commodity and a sign of Wealth and Social rank.

Points to be Discussed

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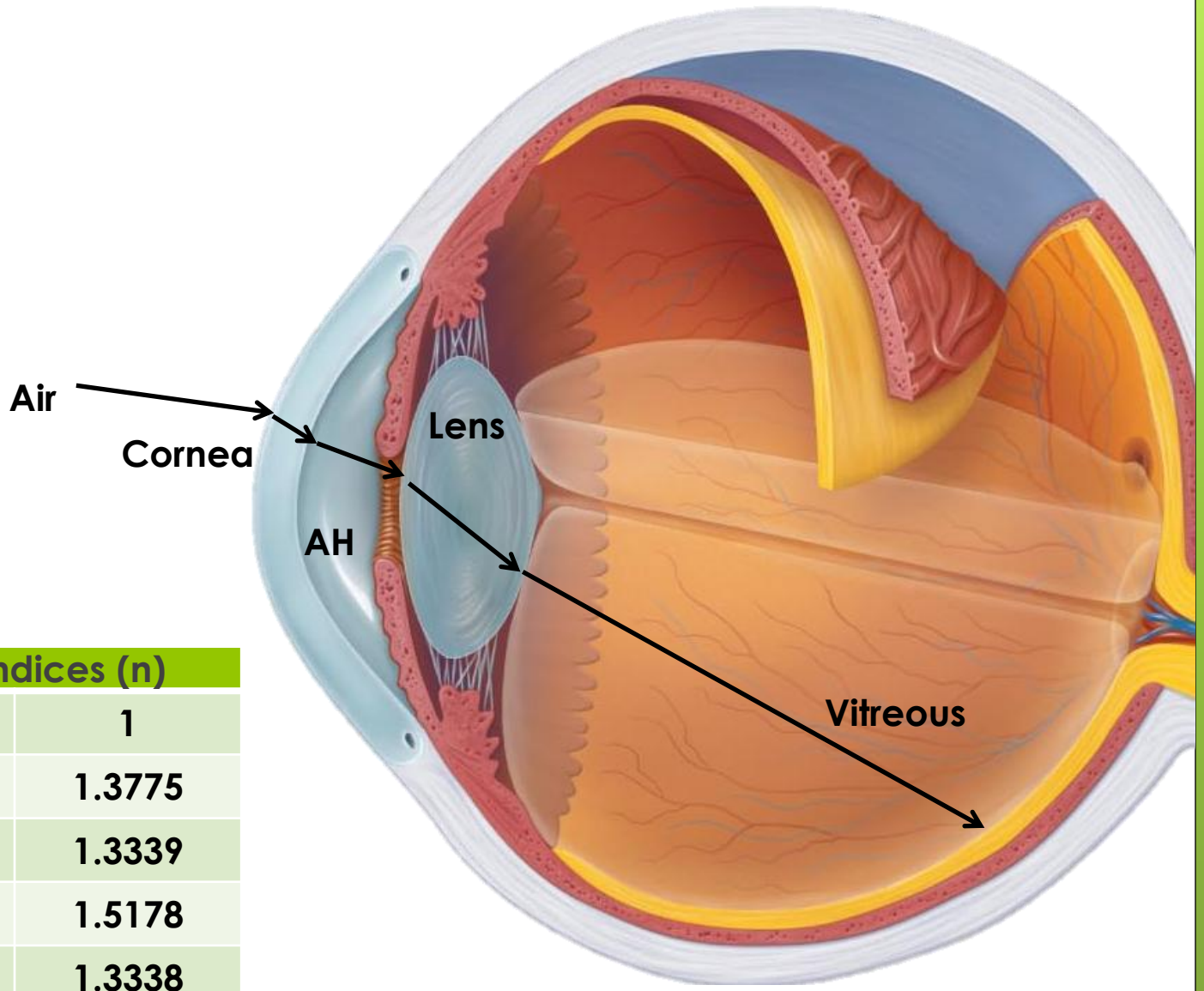
8	Questions?

Theory behind the Schematic eye



Refractive indices (n)		
Air	n_1	1
Cornea	n_2	1.3775
Aqueous	n_3	1.3339
Lens	n_4	1.5178
Vitreous	n_5	1.3338

Points to be Discussed

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Science branches involved.

From where to start

Two science branches are involved in this dilemma, Ophthalmology and Physics of optics or Optometry.

Which comes first?

Study analysis

Ophthalmology comes first through getting the normal measurements of the eye and using these values to study the corresponding Optical Physics.

Who should do this?

Ophthalmologist is the number one-man. The Optometrist's job is to build/construct a hand-on model of the ophthalmologist-provided data.

Points to be Discussed

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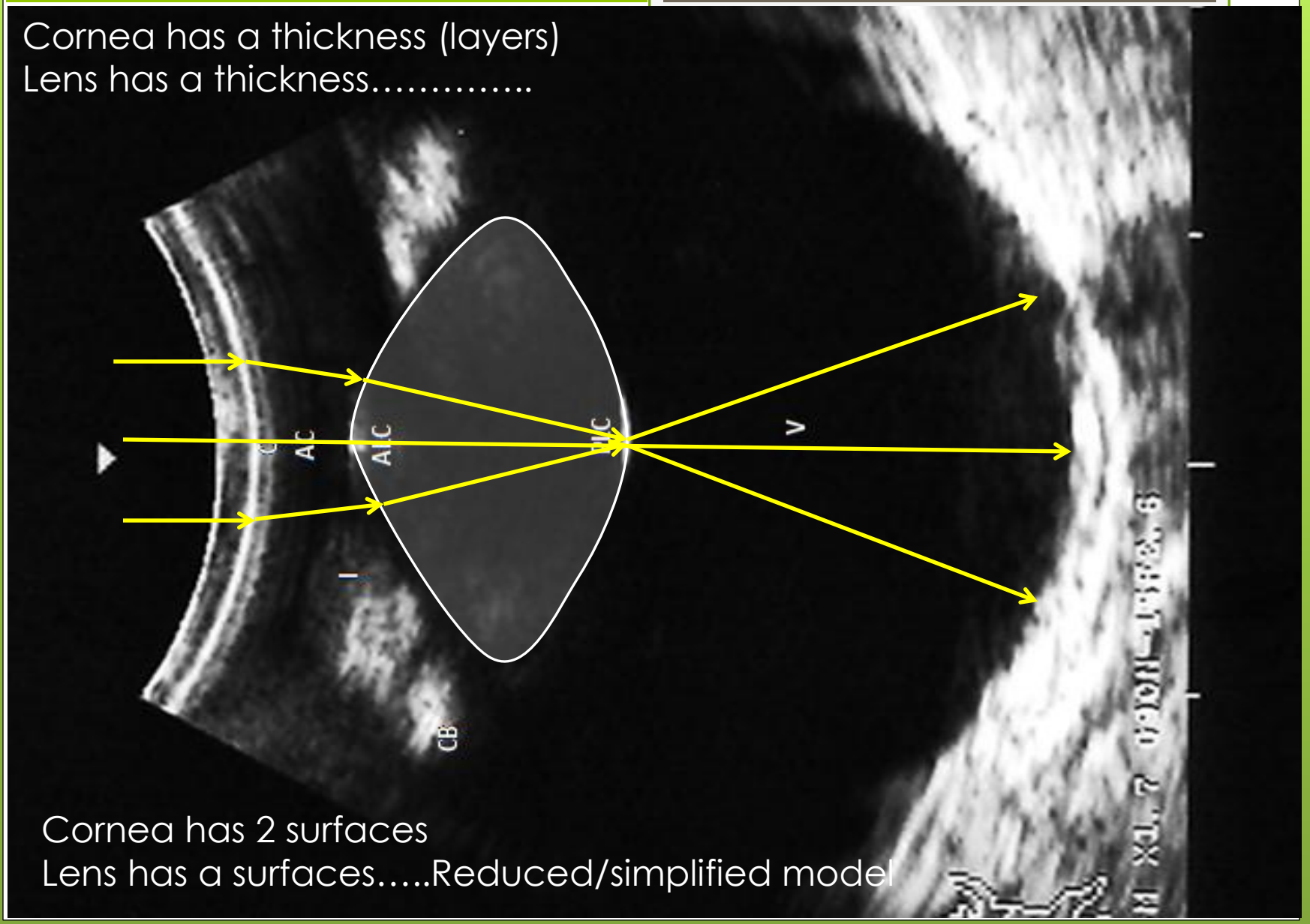
Data Required

Cornea has a thickness (layers)
Lens has a thickness……



Cornea has 2 surfaces
Lens has a surfaces…..Reduced/simplified model

Points to be Discussed

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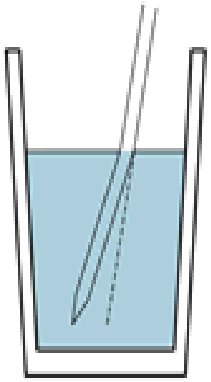
Step: 1

Steps

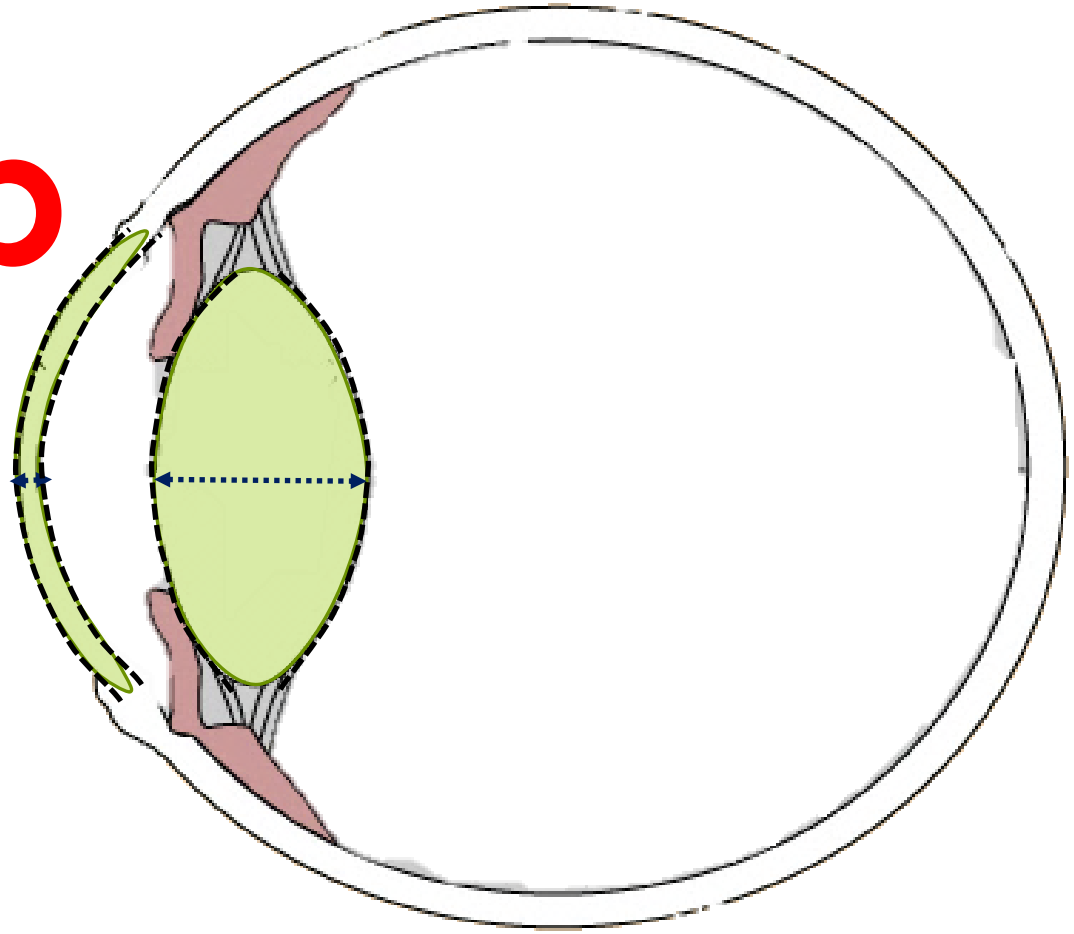
Step **1**: collecting the inputs required to build the schematic model, this included constants as refractive indices, calculating the radii of curvature and the normal measurements of the ocular tissue

a

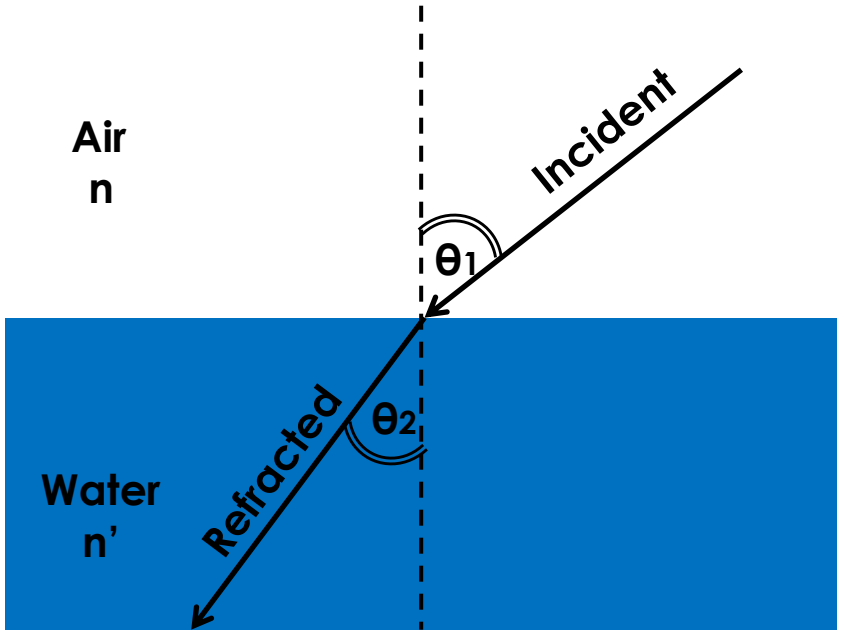


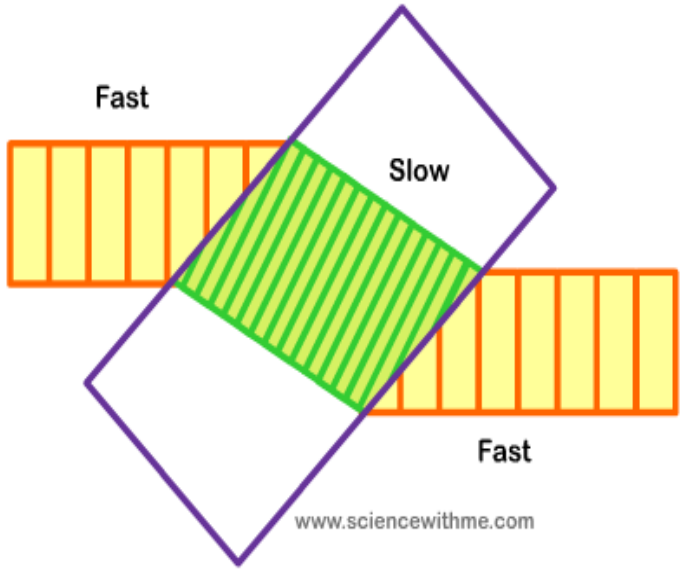
b

c



Steps: (1a) Refractive index





Refraction happens because of the change of the speed of light with different refractive indices

Refractive indices (n)		
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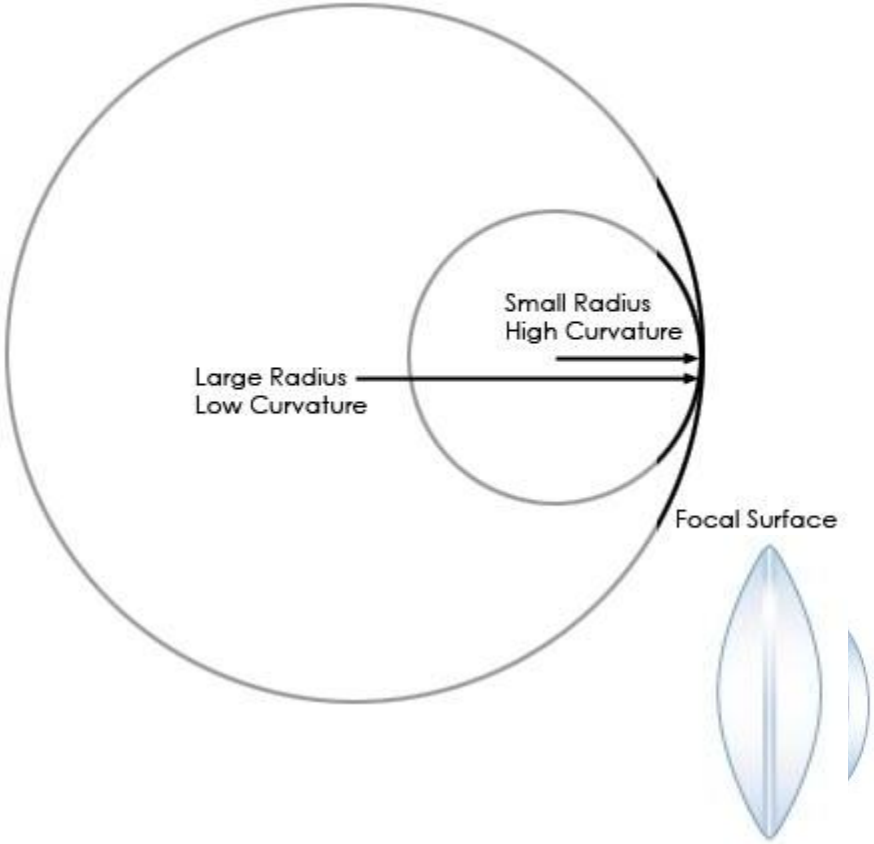
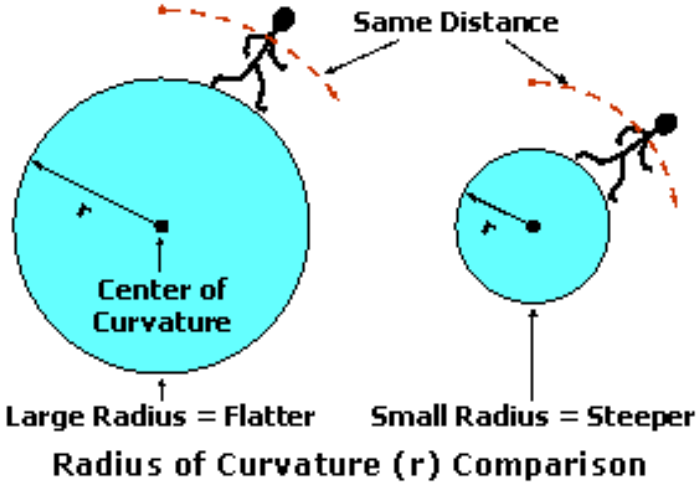
Aqueous	n_3	1.3339
Lens	n_4	1.5178
Vitreous	n_5	1.3338

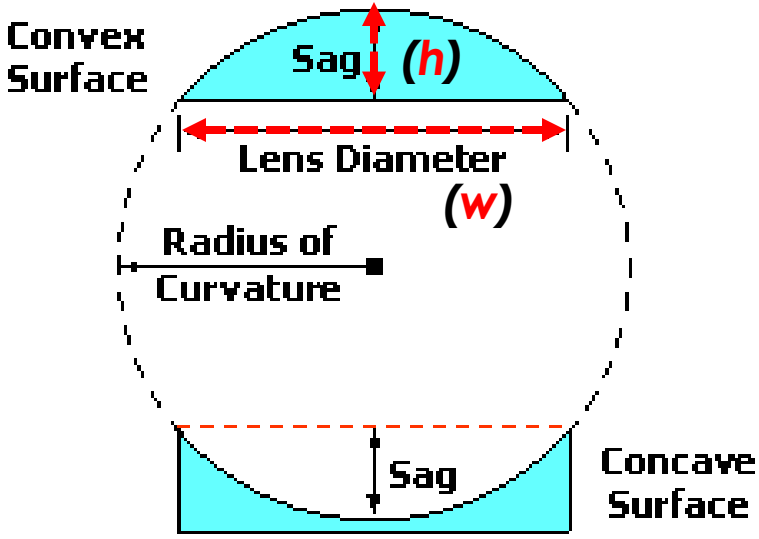
Steps: (1b) Radius of Curvature





Radius of Curvature (r) Comparison

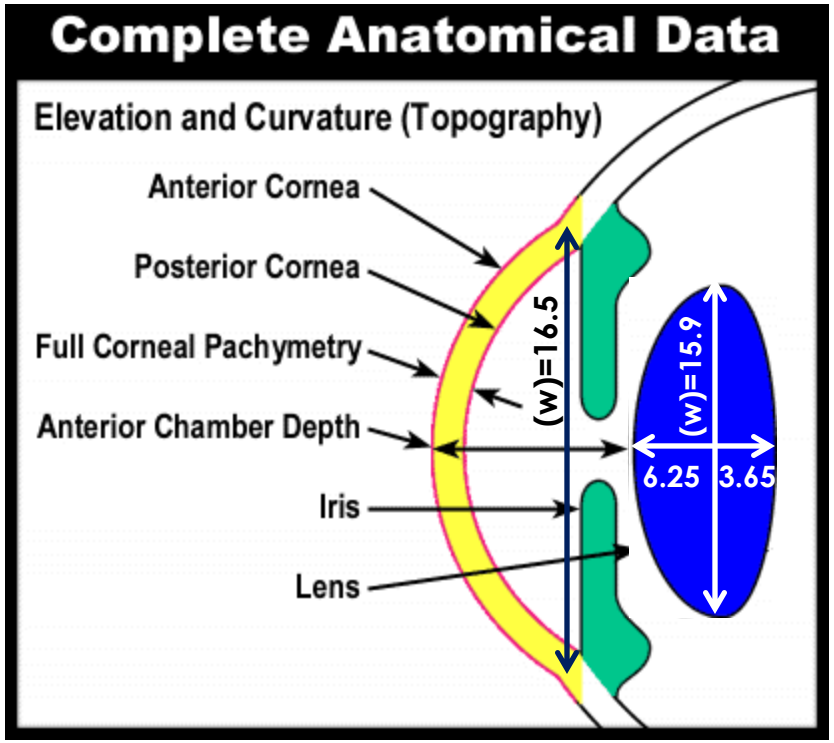
$$r = (4h^2 + w^2)/8h$$

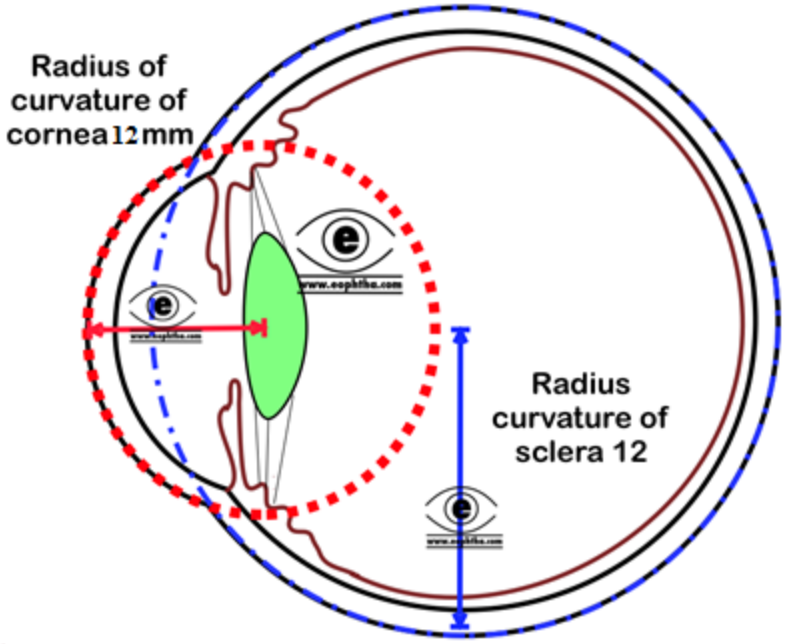


r= radius of curvature, w= width, h= height

Geometry of a Lens Surface

Steps: (1b) Radius of Curvature



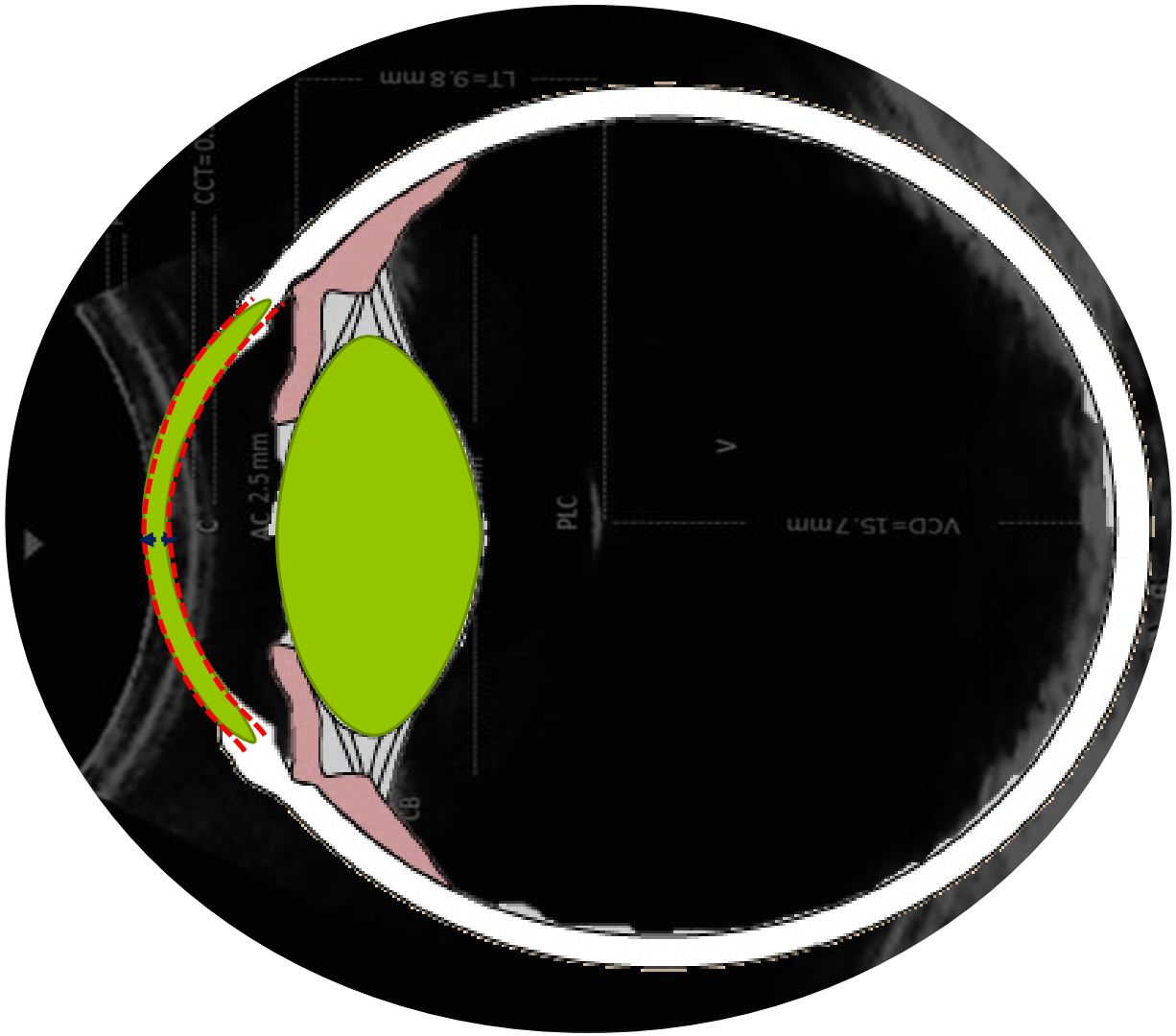


$r = (4h^2+w^2)/8h$

Distance (*h*) from Anterior cornea vertex to			Radii of curvature		*r*
Posterior Cornea	t_1	0.9	Anterior Cornea	r_1	12.096
Anterior Lens		3.25	Posterior Cornea	r_2	15.656
Posterior Lens	d_1	12.85	Anterior Lens	r_3	8.181
Retina	d_2	28.45	Posterior Lens	r_4	-10.483

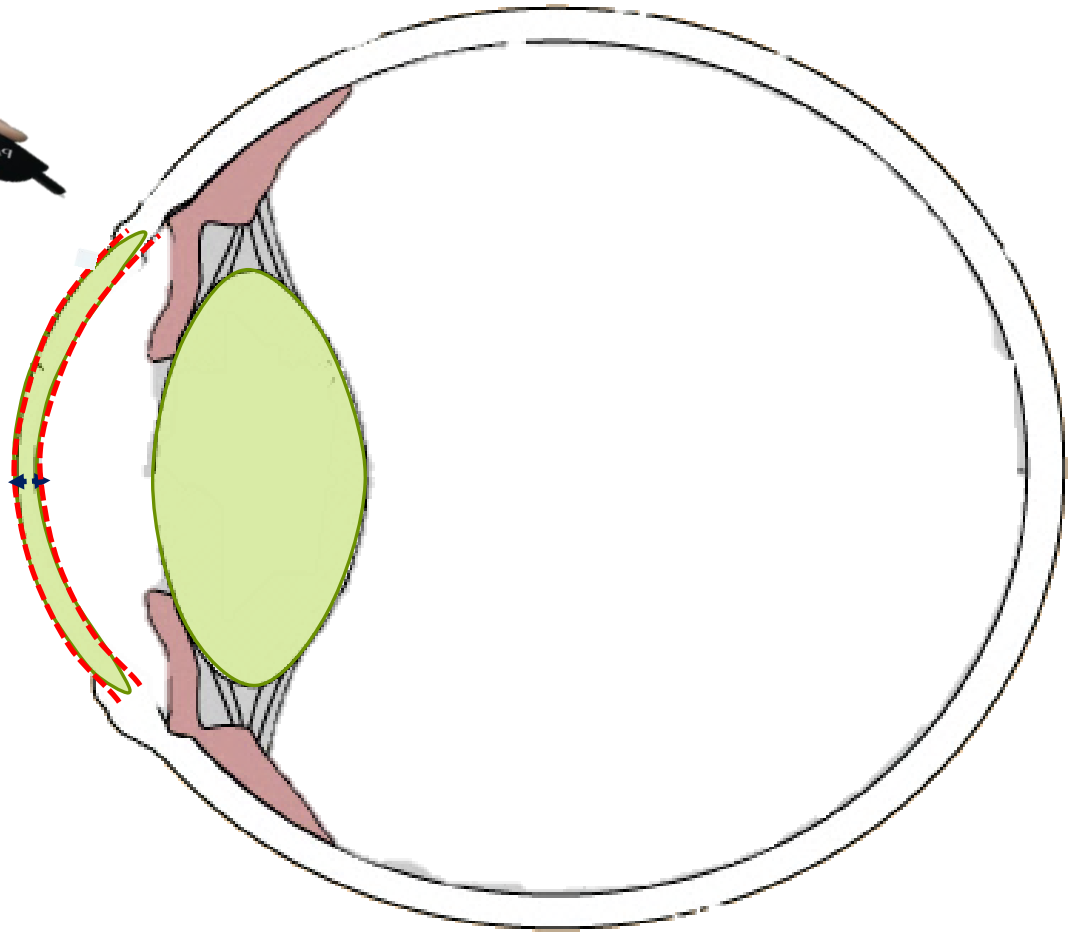
Steps: (1c) i- Corneal-Thickness

1- Ophthalmic ultrasonography



Steps: (3) i- Corneal-Thickness

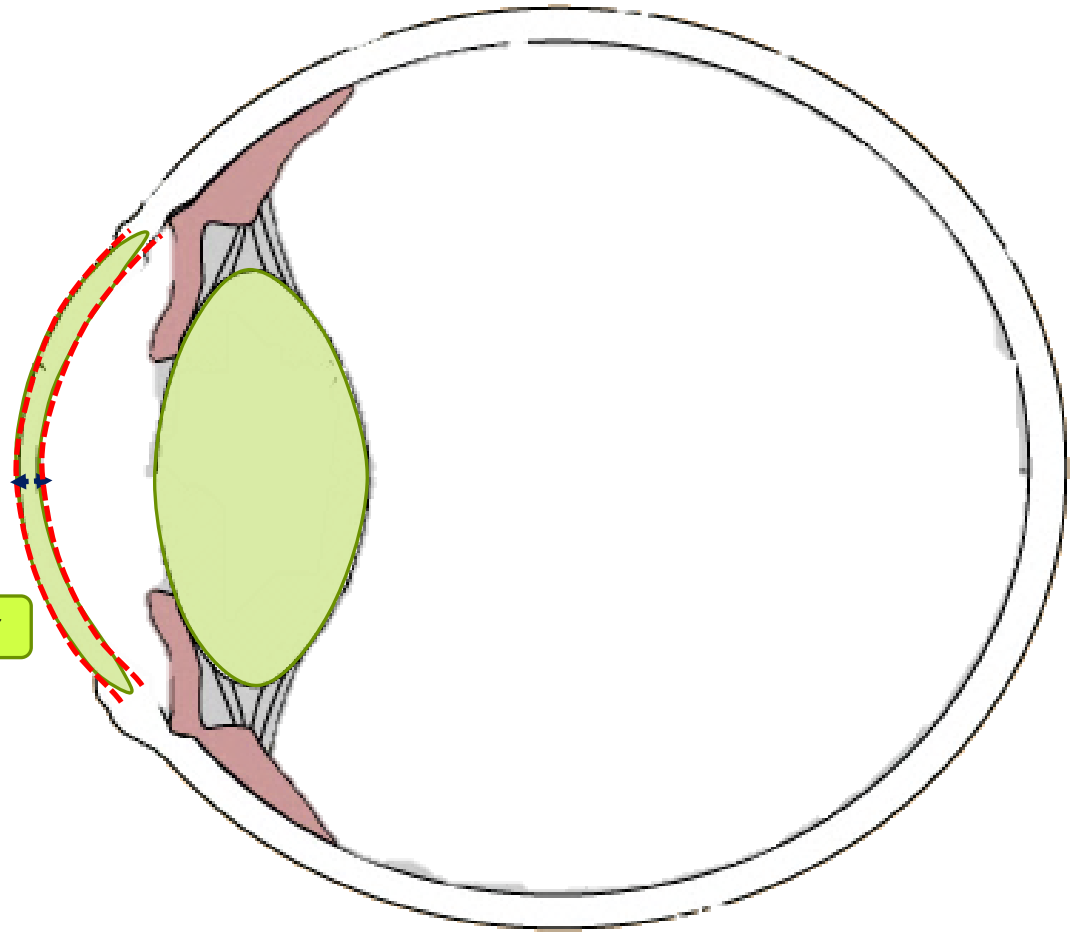
2- Pachymetery for cornea thickness (ultrasonic &optical)



Steps: (3) i- Corneal-Thickness

3- Partial Coherence Interferometry (PCI), laser-Doppler

4- High-speed Optical Coherence Tomography (OCT)

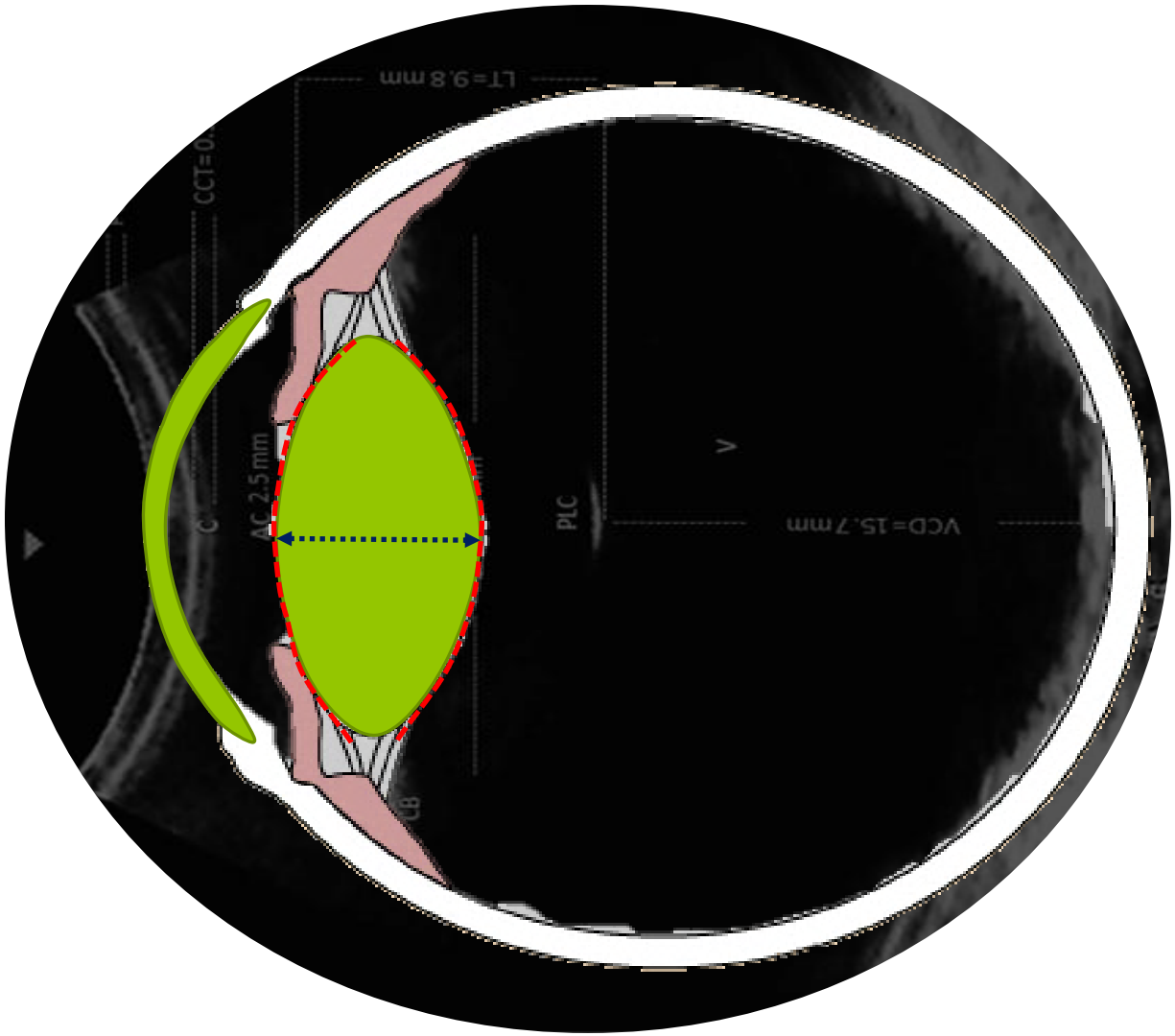


5- MRI

6- Keratometer

Steps: (3) ii- Lens-Thickness

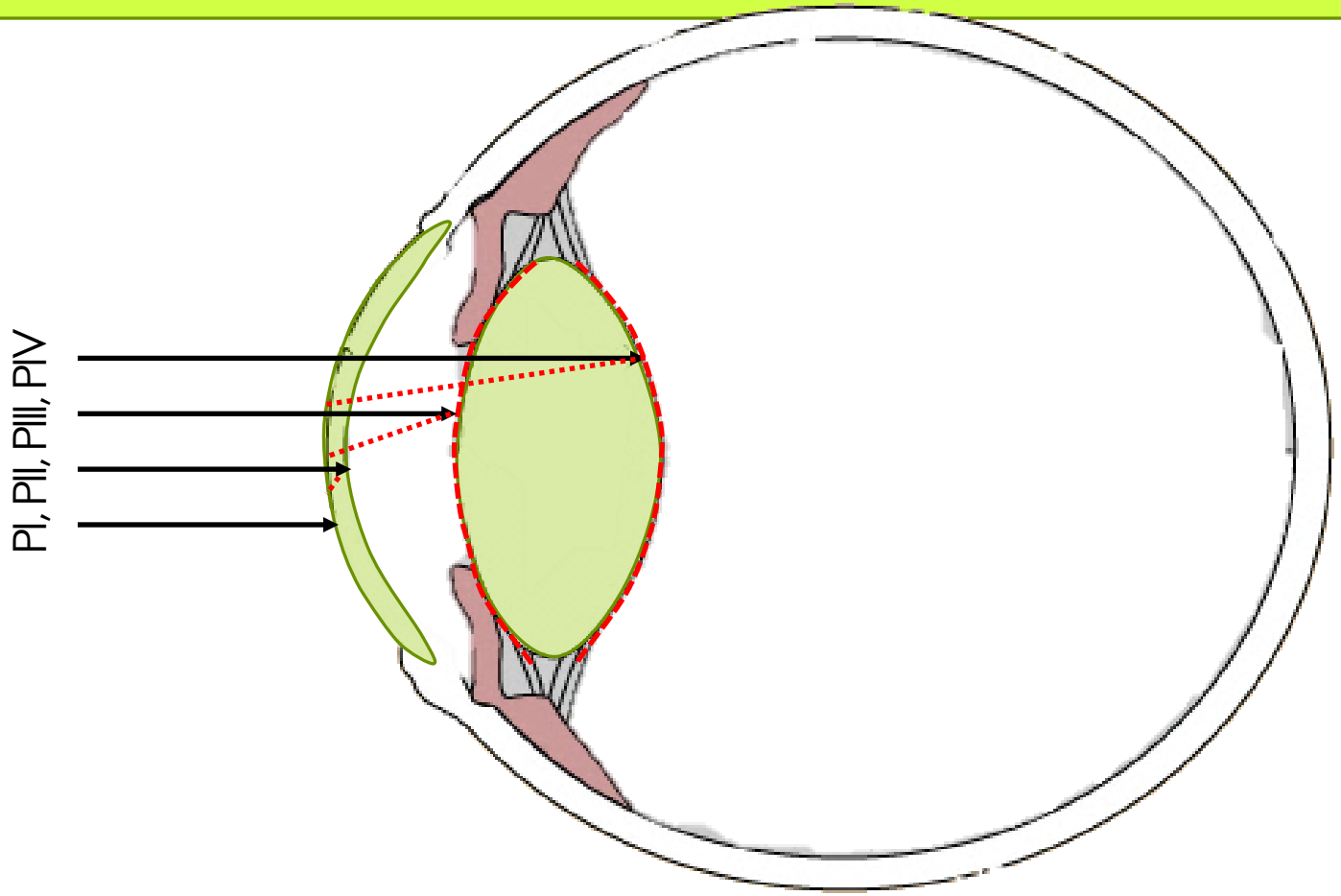
1- Ophthalmic ultrasonography



Steps: (3) ii- Lens-Thickness

2- High-speed Optical Coherence Tomography (OCT)

3- Purkinje Method seq. of reflections from the eye refracting surfaces

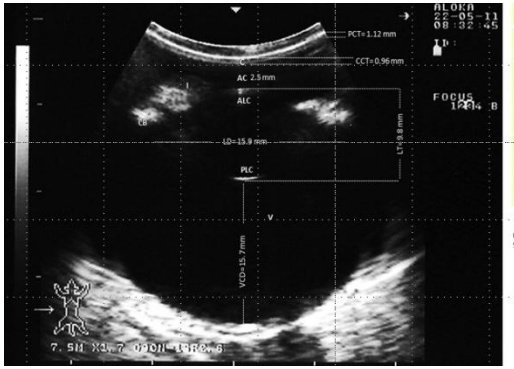


Steps

Step: 2

Steps

Building a theoretical/physical model based on the inputs and obtaining it's theoretical visual properties (such as the lens power, focal distance and focal points, …etc).



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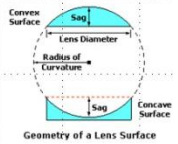
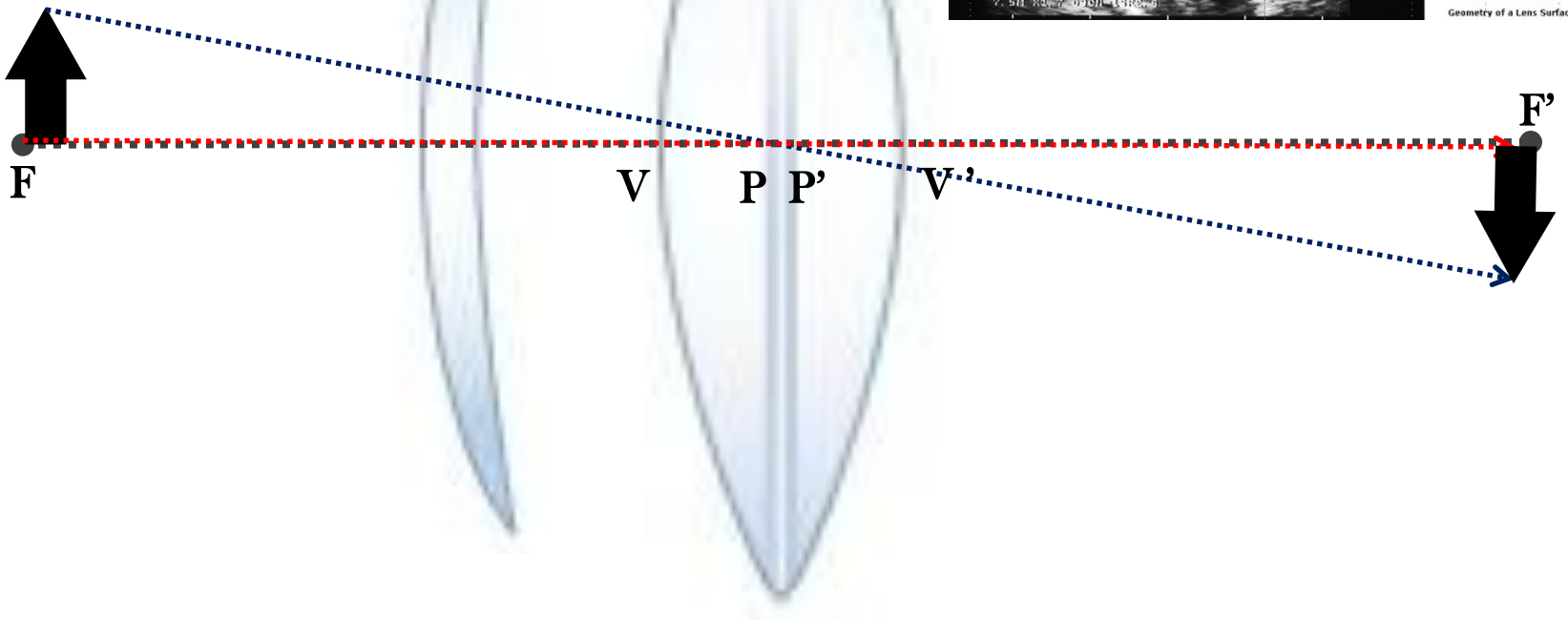


Geometry of a Lens Surface



Consider

Points to consider

1-age of animal
The dimensions of ocular tissues vary from infantile to adult animals. These changes are probably the necessary concomitant of the increase in size of the eye during growth.

2-Adaptation (no adaptation is calculated).

Step: 3

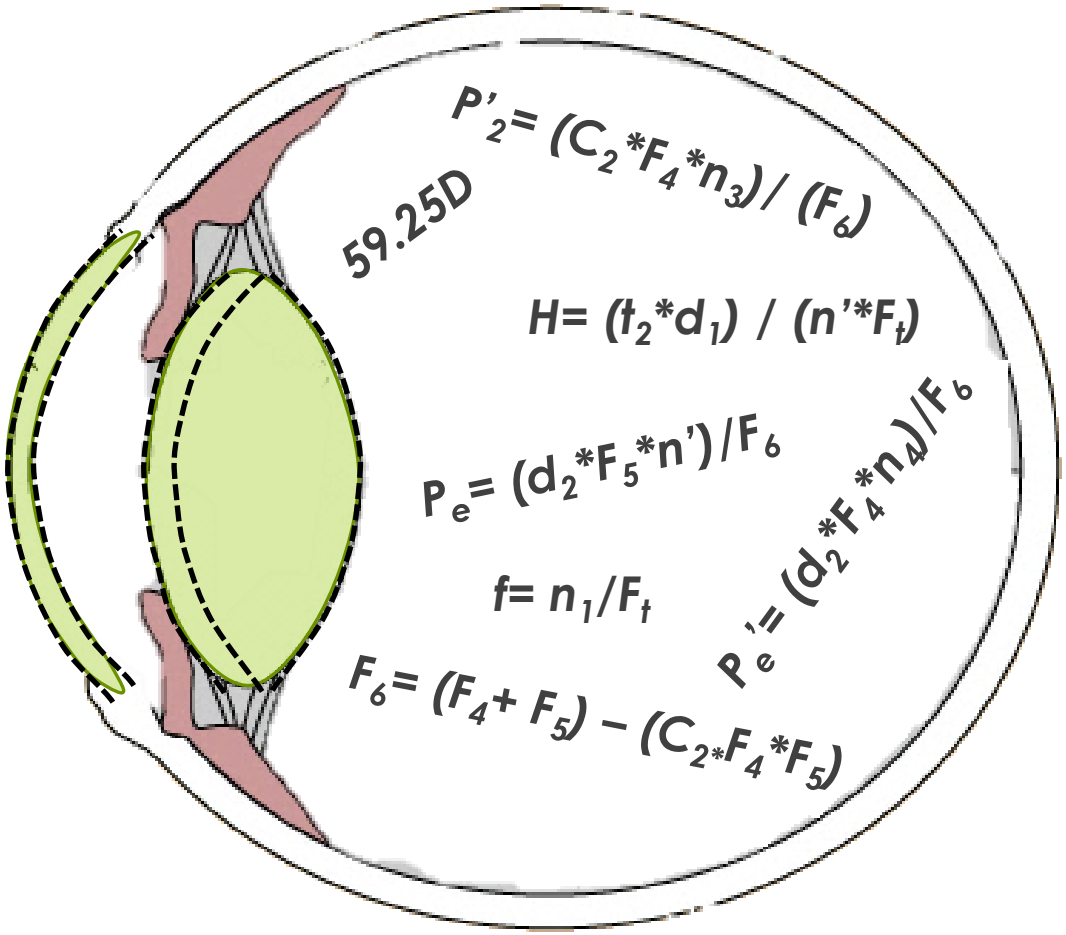
Steps

Step **C**: Two eye models can be developed; Full **schematic**/Reduced

Thick lens theory

≈

Thin lens

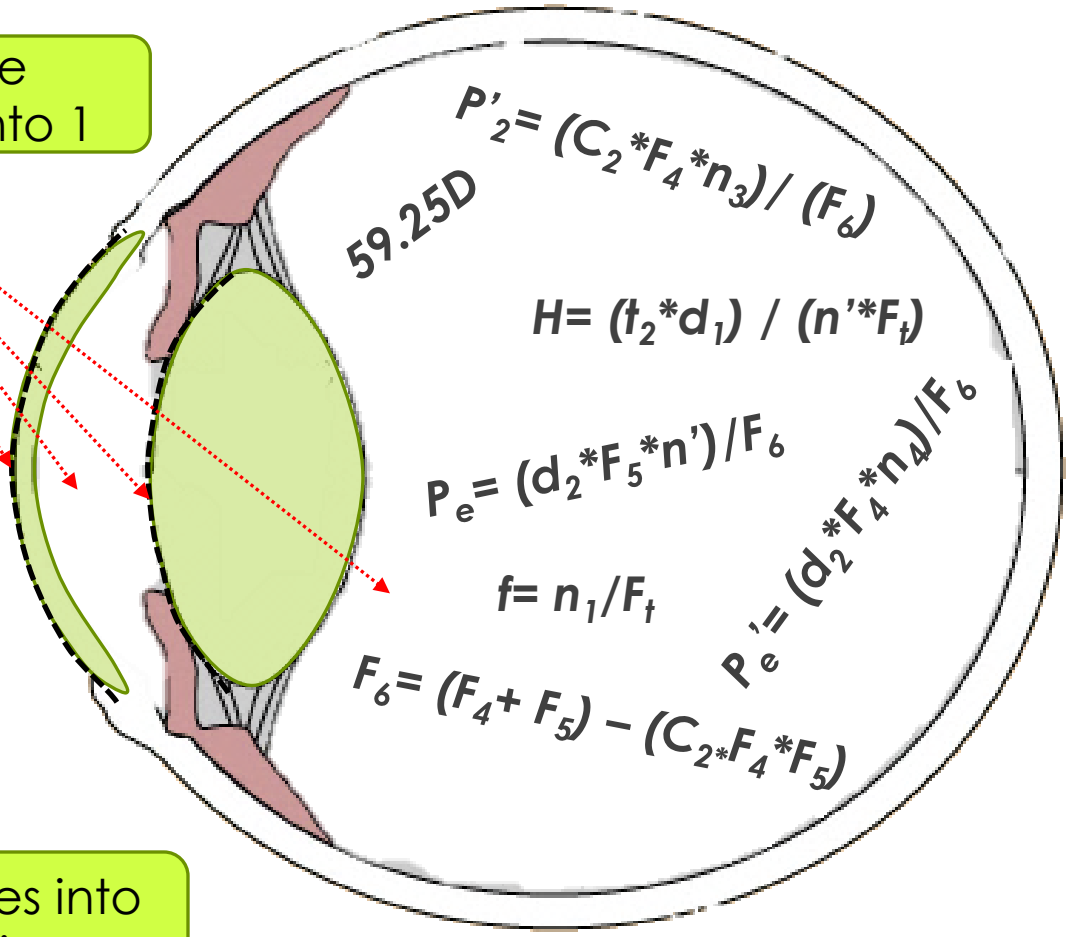


Steps

Step **C**: Two eye models can be developed; Full schematic/**Reduced**

To make simple optical calculations

combining all the refractive indices into 1



all refracting surfaces into 1-power, 1-location

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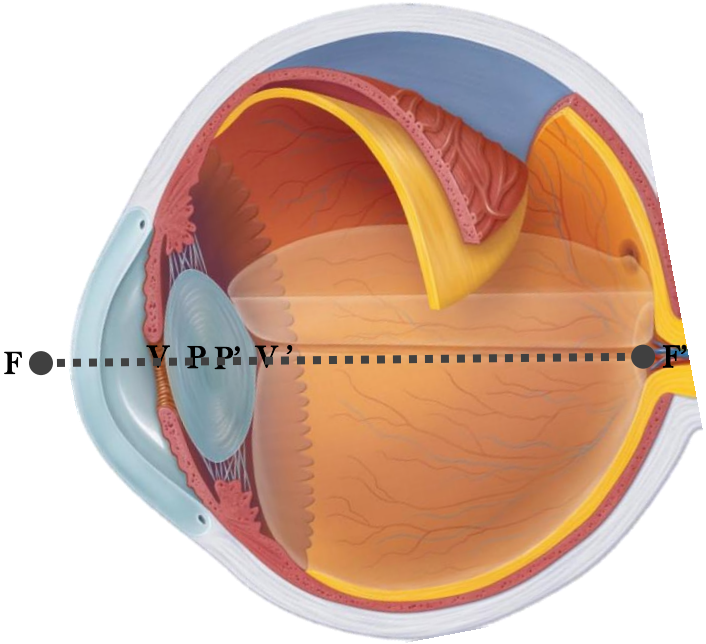
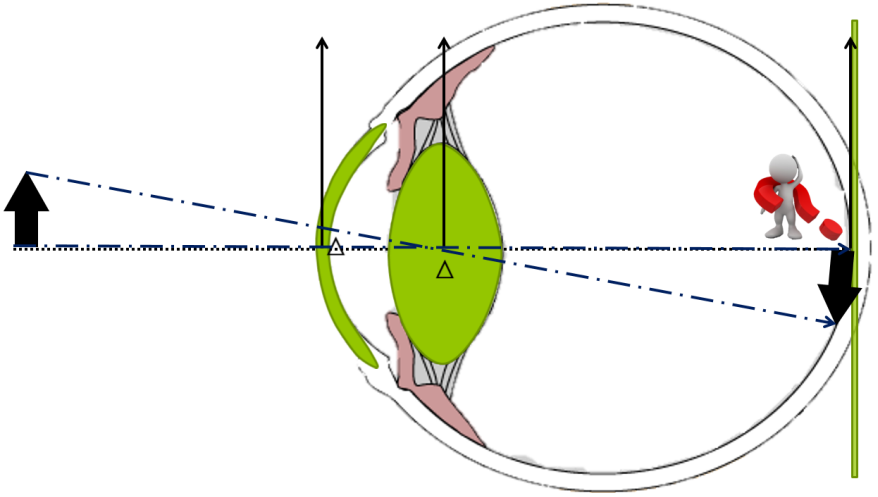
Steps



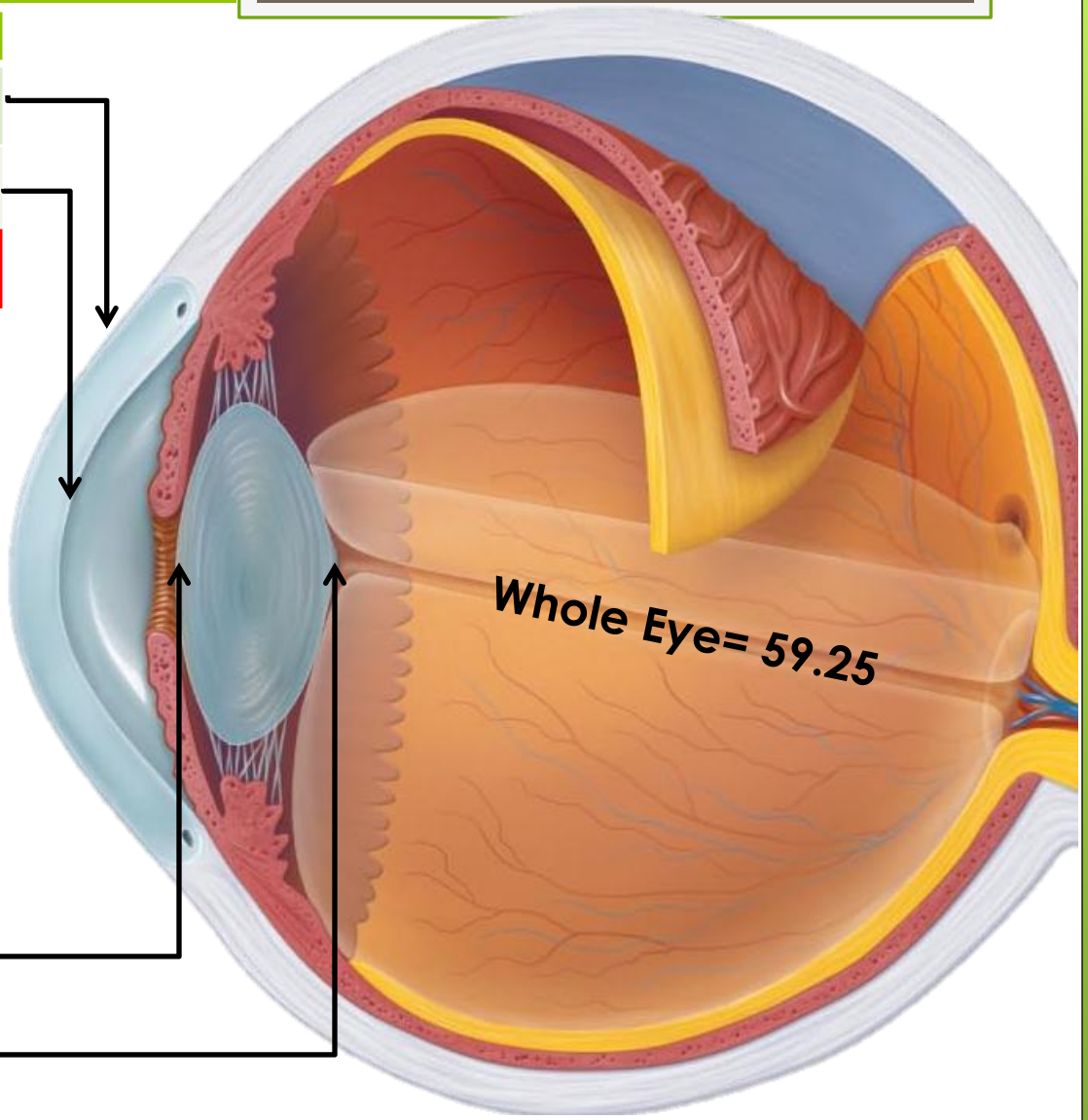


Comparing the obtained data with the measured data on live animals and interpreting the results

Results

Refractive power-Cornea/Lens/Eye

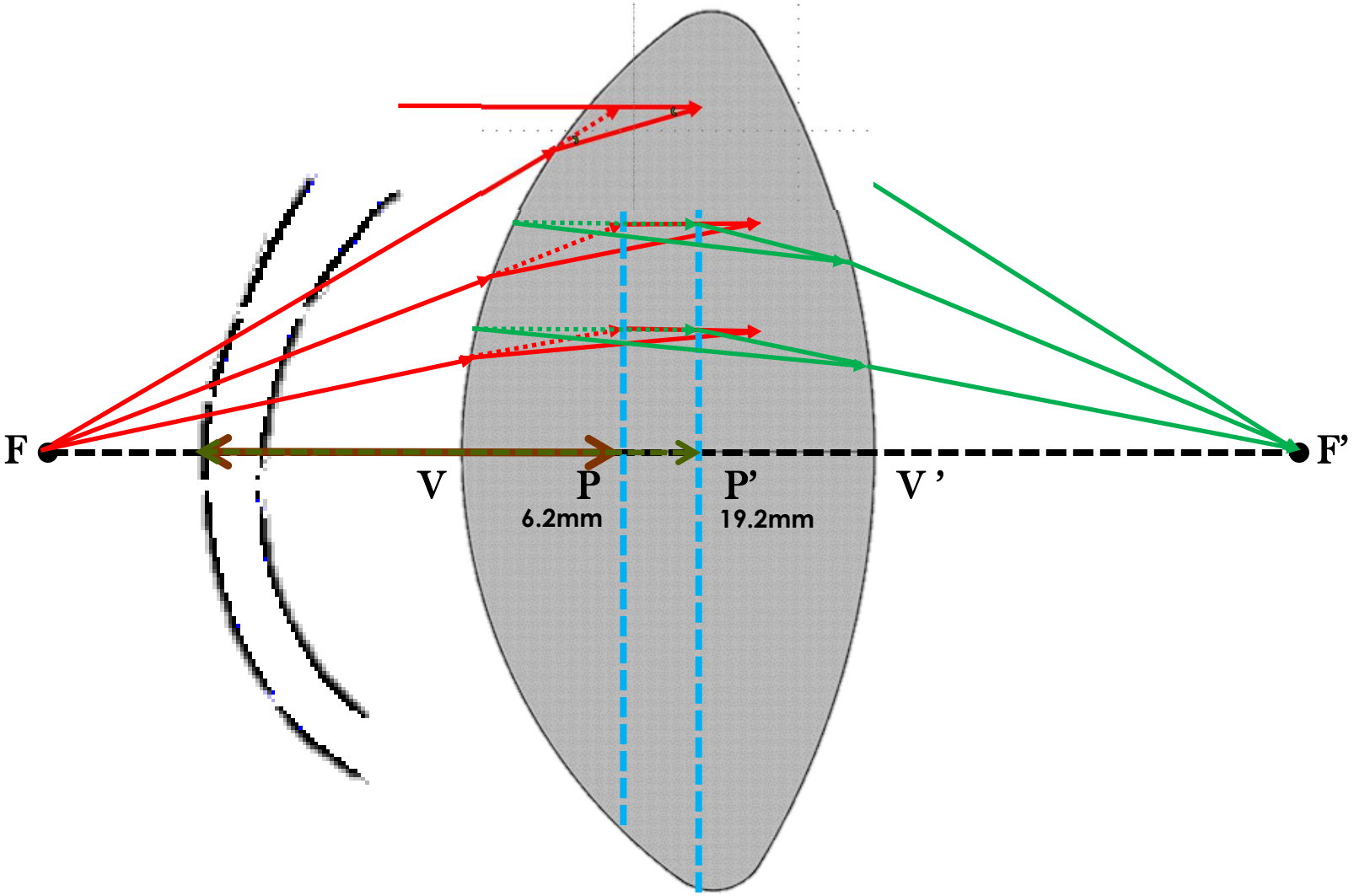
Powers	
Anterior Cornea	31.2087
Posterior Cornea	-2.7849
Total Cornea	28.481



Anterior Lens	22.4789
Posterior Lens	17.5522
Total Lens	37.5356

Results

Principle points 1/5

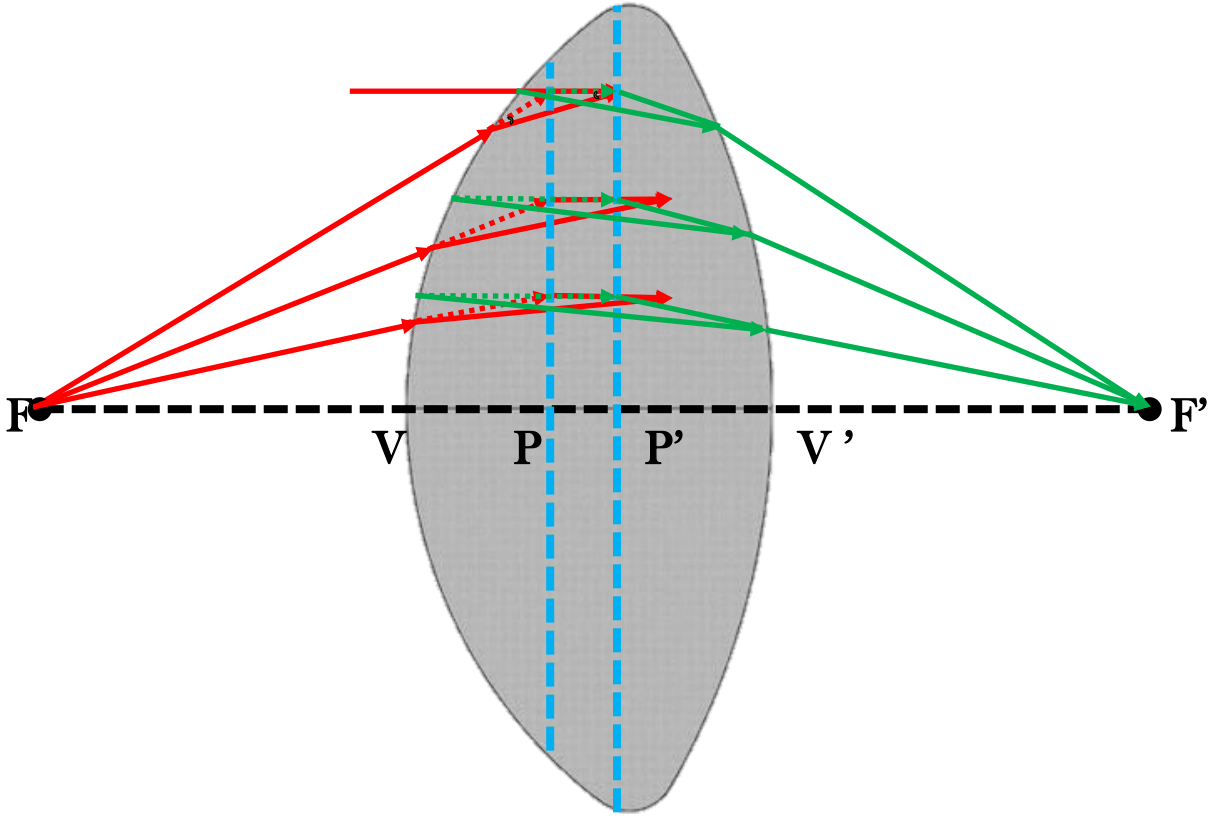


F,F'= focal points, V,V'= vertices, P,P'= principle points

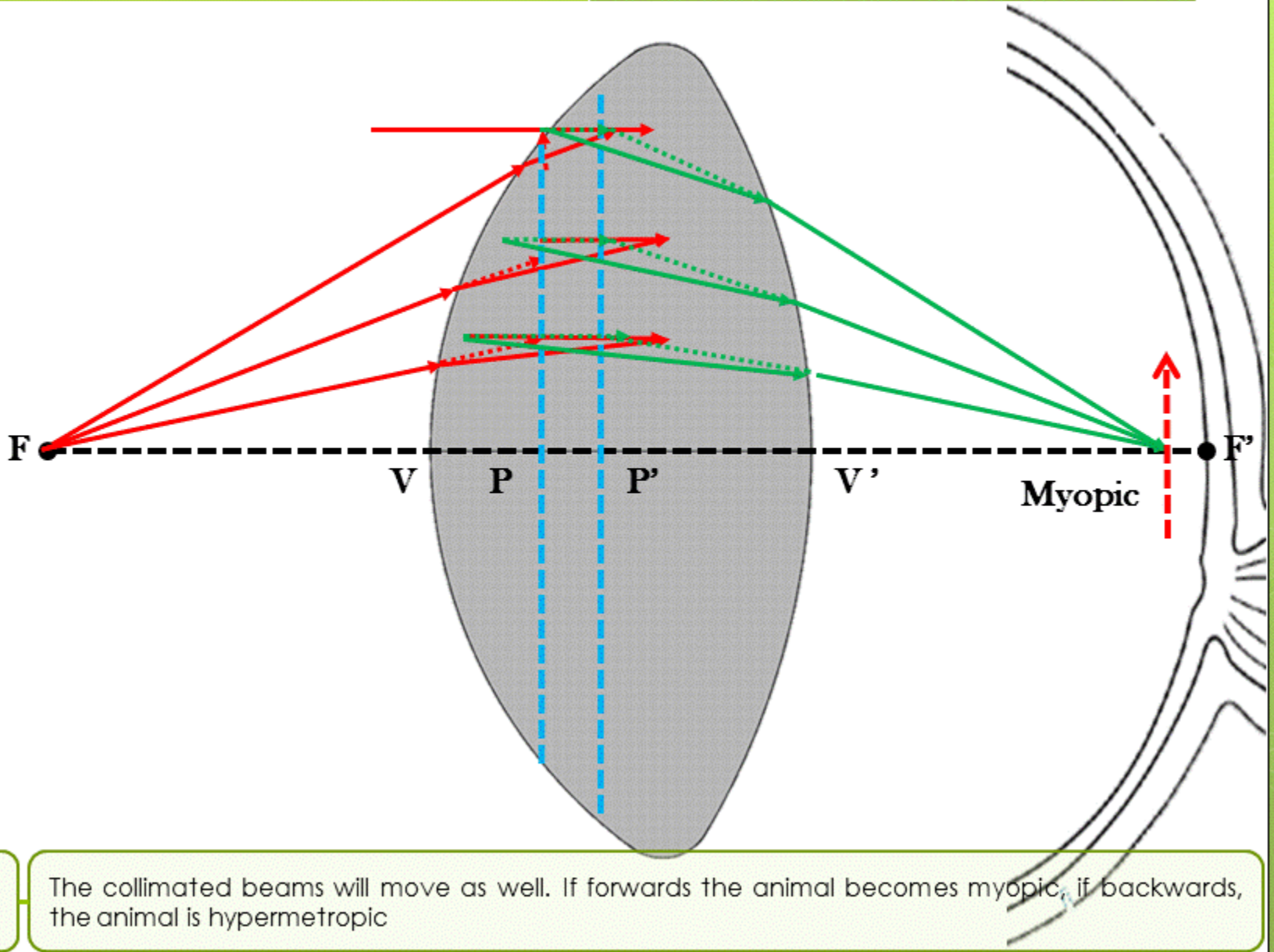
Results

Principle points 2/5

1	What happens if the P moves forward or backward**?**
2	What is the value of knowing the exact mathematical P-points**?**



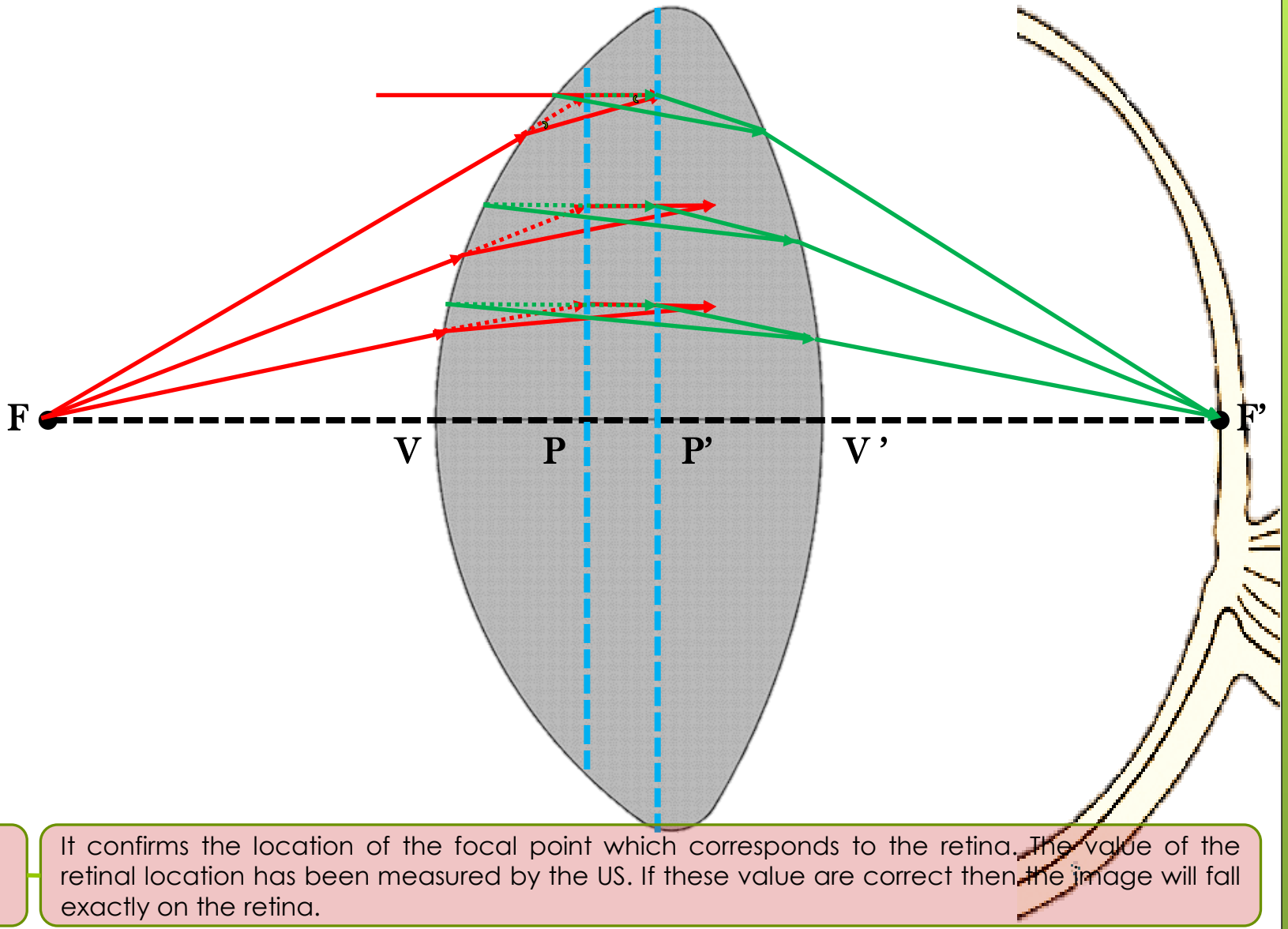
Principle points 3/5



1 The collimated beams will move as well. If forwards the animal becomes myopic, if backwards, the animal is hypermetropic

Results

Principle points 5/5

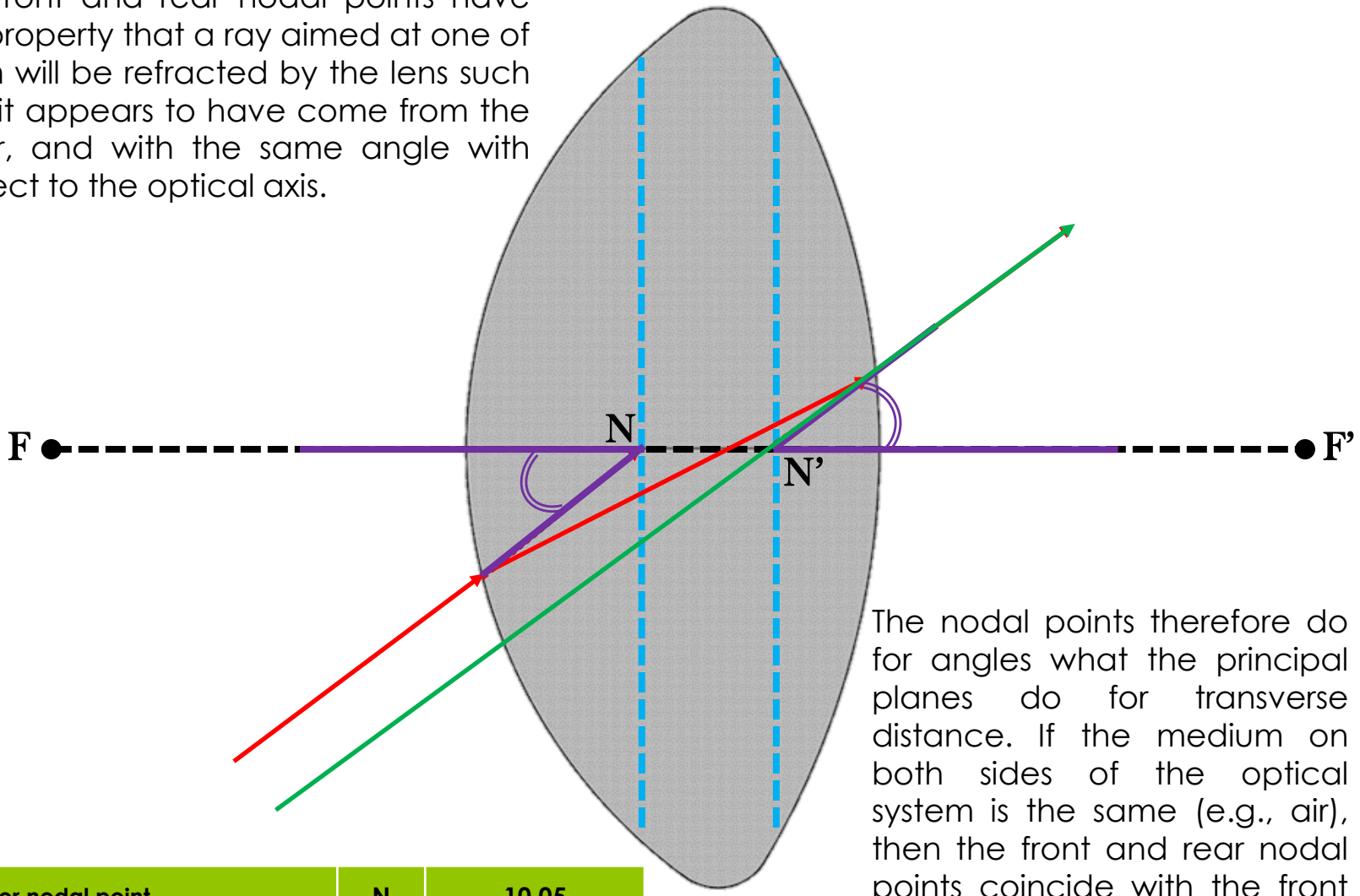


2 It confirms the location of the focal point which corresponds to the retina. The value of the retinal location has been measured by the US. If these value are correct then the image will fall exactly on the retina.

Results

Nodal points

The front and rear nodal points have the property that a ray aimed at one of them will be refracted by the lens such that it appears to have come from the other, and with the same angle with respect to the optical axis.

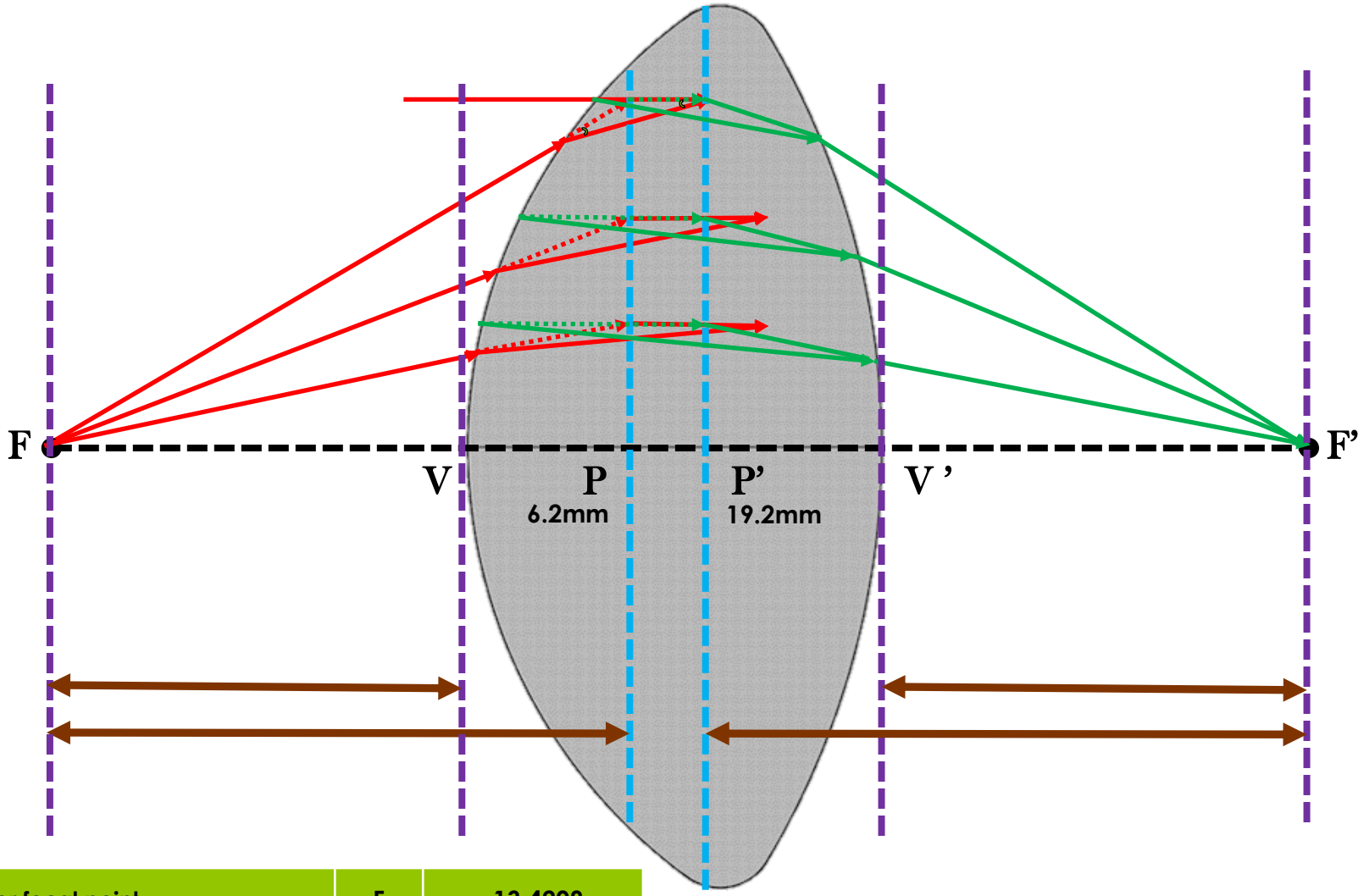


Anterior nodal point	**N**	**10.05**
Posterior nodal point	**N'**	**11.219**

The nodal points therefore do for angles what the principal planes do for transverse distance. If the medium on both sides of the optical system is the same (e.g., air), then the front and rear nodal points coincide with the front and rear principal points, respectively.

Results

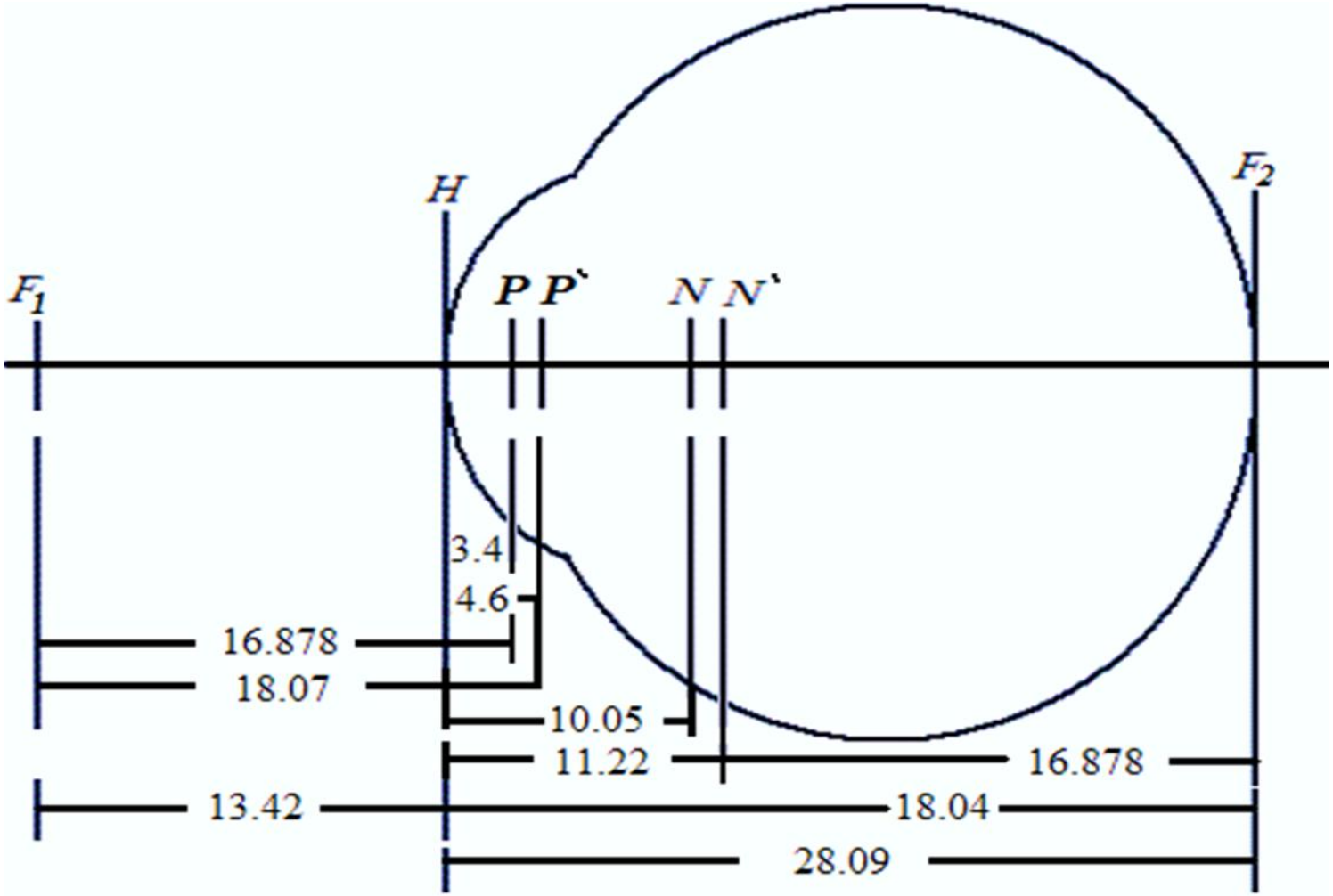
Focal points



Anterior focal point	F	-13.4208
Posterior focal point	F'	28.0961

Results

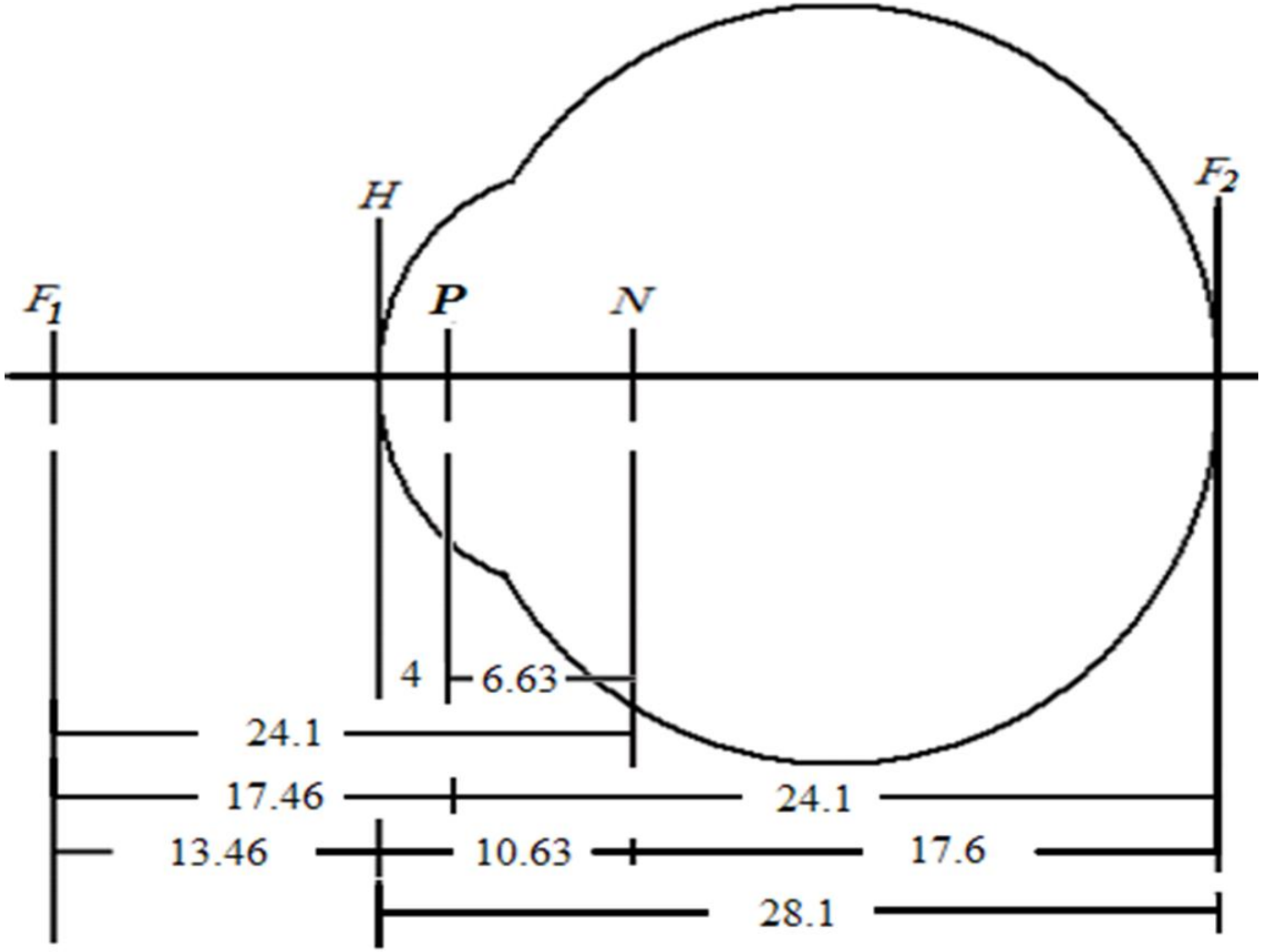
Full Schematic eye



Anterior focal point	F	-13.4208
Posterior focal point	F'	28.0961

Results

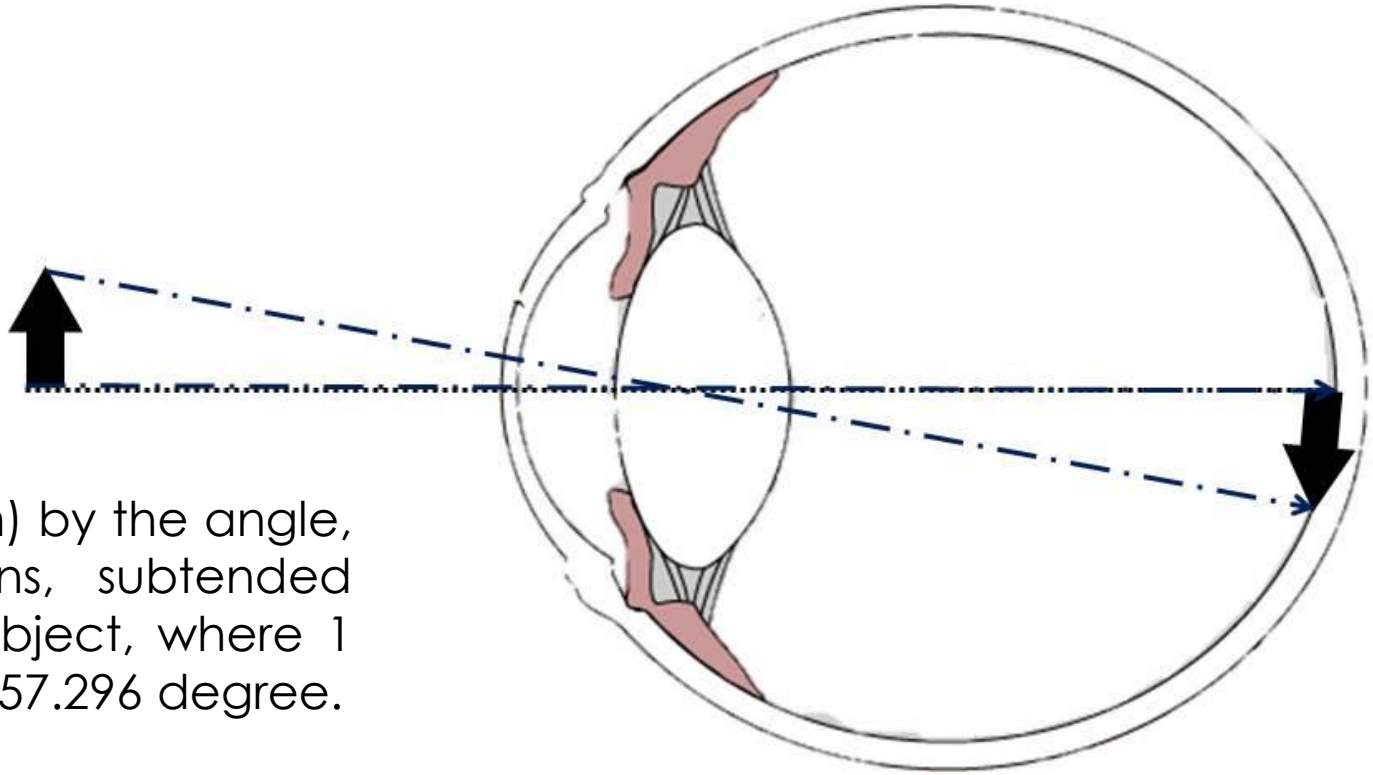
Reduced eye



Results

RIM (Retinal Image Size/Magnification)

The retinal image size is calculated by multiplying the distance from the posterior nodel point to the retina



(17.6 mm) by the angle, in radians, subtended by the object, where 1 radian = 57.296 degree.

If the same object moves closer, the subtending angle will increase, the larger the retinal image size

Consider

Clinical values

Industry

Artificial IOL design to compensate visual defects.

In Human: Spectacles and contact lenses.

Consider

Clinical values

Surgery
For visual rehabilitation of animals suffering from cataract and/or other Refractive surgery.
LASIK

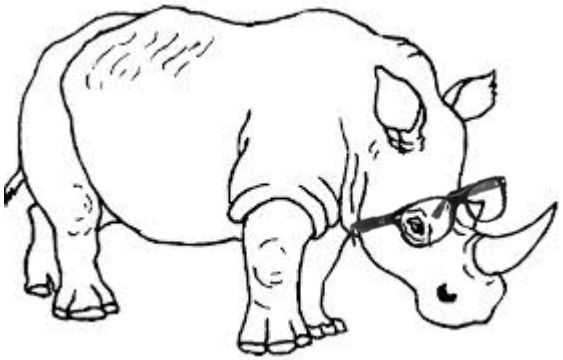
Clinical values

Consider

Optical properties of animal eye

Mice are Myopic (Optical properties of the mouse eye, Ying Geng,1,2,* Lee Anne Schery,1 Robin Sharma,1,2 Alfredo Dubra,1,3 Kamran Ahmad,1Richard T. Libby,1,3 and David R. Williams1,2,)

Rabbits can see what's behind them.
They are also however, myopic



Rhinos are myopic

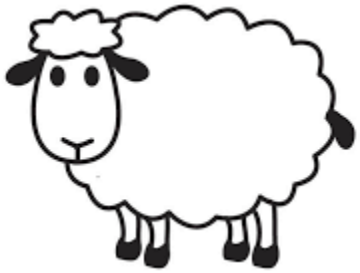
Most dog breeds have good vision, but some show a genetic predisposition for myopia – such as Rottweilers (Coren, Stanley (2004). How Dogs Think. First Free Press, Simon & Schuster. ISBN 0-7432-2232-6.)

Consider

Clinical values

Optical properties of animal eye

Many domestic horses (1/3) tend to have myopia, with few being far-sighted. Wild horses, however, are usually far-sighted. Giffin, James M and Tom Gore. *Horse Owner's Veterinary Handbook, Second Edition*. Howell Book House. New York, NY. Copyright 1998.



Sheep are hyperopic with large RIM

Eagles, young: myopic, adult no

Consider

Clinical values

Optical properties of animal eye **Ocular size and Lens power/accom.**

The data obtained from the schematic model shows that camels with their relatively small sized-eyes compared to horse and cow necessitated the existence of an optical system with a higher dioptric power to achieve image focusing over a short focal length.

Camels has normal vision but with a great capability of lens accommodation.

Ocular size		diopter
Camel	**29.1**	**59.25**
Horse	41.4	38.5
Cow	36	

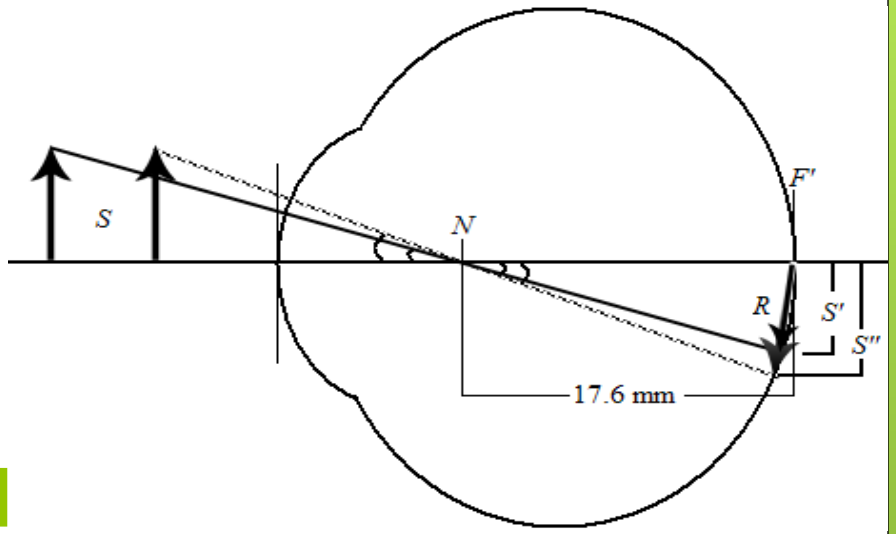
Consider

Clinical values

Optical properties of animal eye **(RIM)**

The retinal image magnification (RIM) indicates the visual acuity and inversely proportional to the lens power.

the stronger the lens, the smaller the retinal image size will become, the better the visual acuity is



RIM	
Camel	**16.89**
Horse	**25.9**
Cow	**20.98**

Consider

Clinical values

Optical properties of animal eye

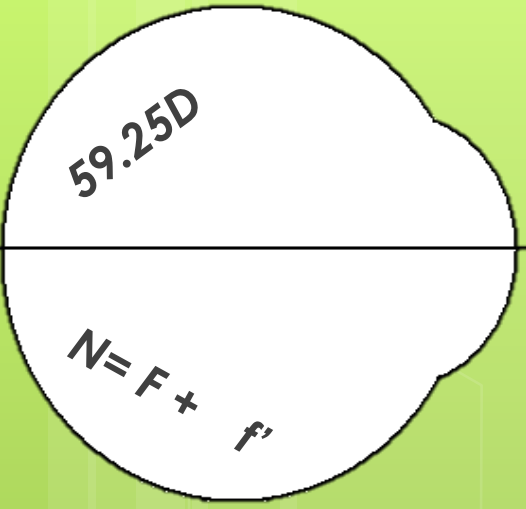
Visual acuity and sensitivity to motion

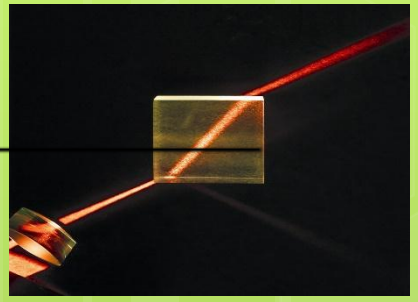
The visual acuity of the horse, or how well it is able to see details, is around 20/33. This is slightly worse than the usual 20/20 in humans, but much better than the visual acuity of dogs (20/50), cats (20/75), and rats (20/300).[13] However, it is difficult to test an animal's visual acuity, so the results may vary between studies.

Animal Eye Care. "About animal vision." Accessed March 11, 2010

Points to be Discussed

1. Eye vs "*Schematic eye*", models of Schematic eye
2. Benefits/Values of schematic eye (Social/Clinical)
3. Theory behind the Schematic eye
4. Science branches involved and their interaction.
5. What is the required data?
6. Steps: 1 (a, b& c), 2 & 3
7. Interpretations of obtained results
8. Questions?





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Constructing Schematic Eye Requirements, Steps and the Obtained clinical values. A Camel-eye model

Thank you