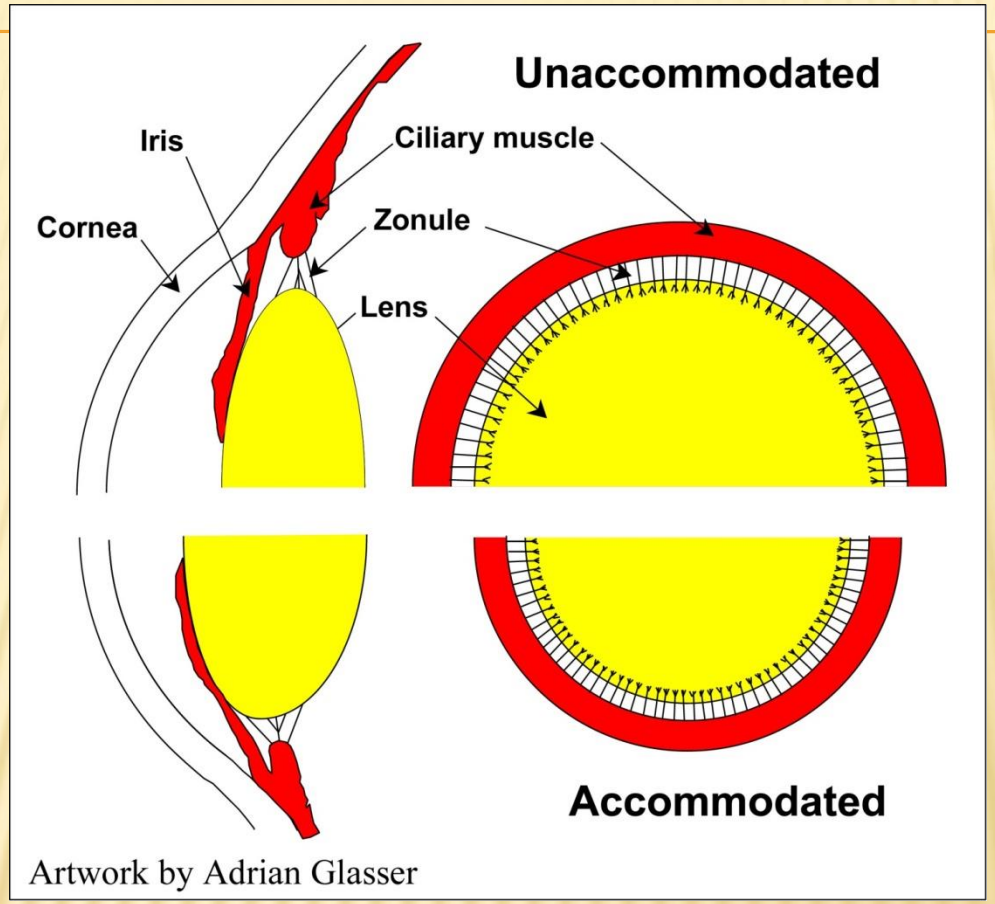
Theory. Actuating mechanisms of accommodation and development of the theory of accommodation by Helmholtz

3th Global Pediatric Congress

23 March 2018 London

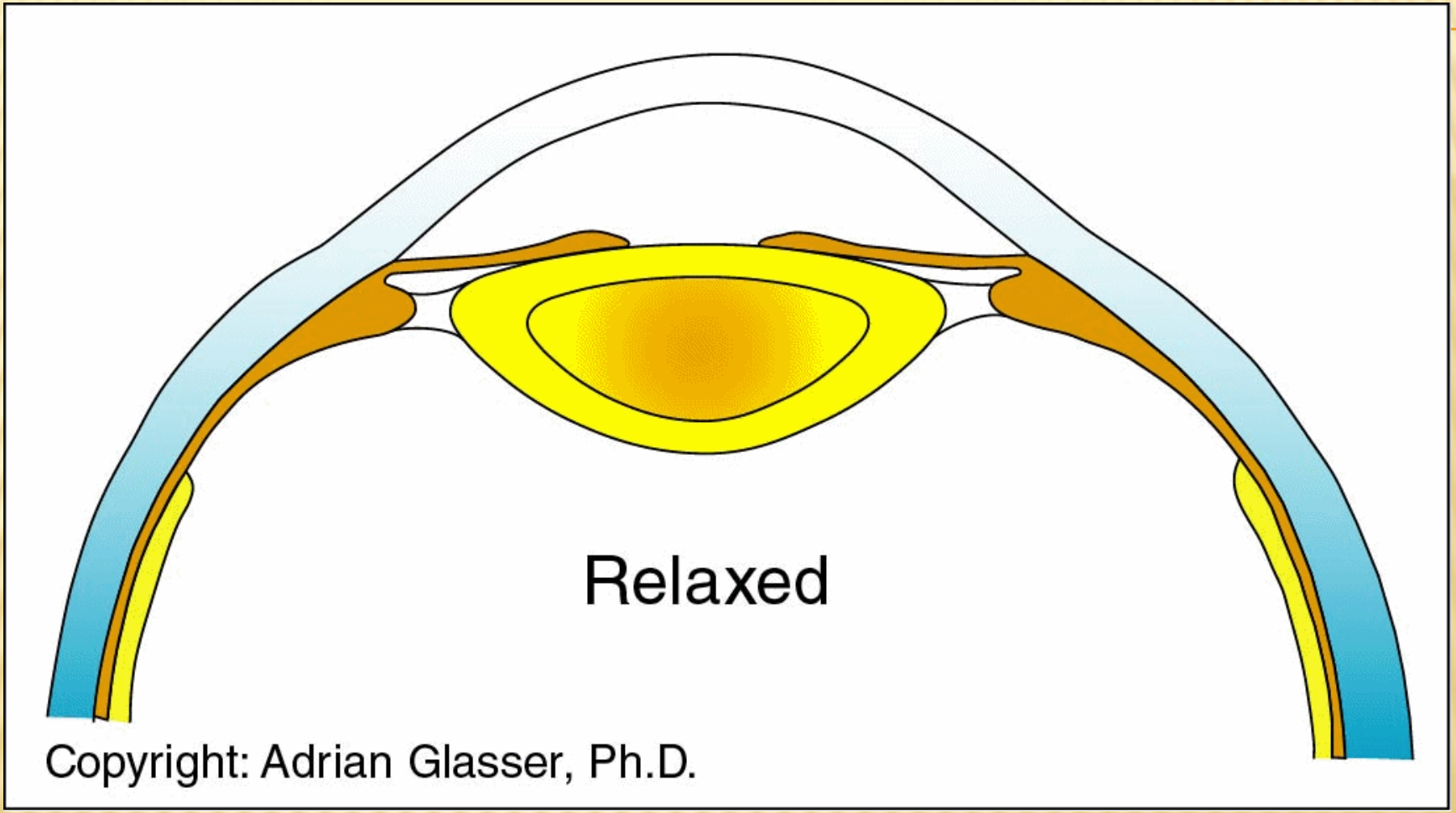
North-Western State Medical University named after I.I. Mechnikov, Saint-Petersburg, Russia

THE MECHANISM OF THE LENS ACCOMMODATION



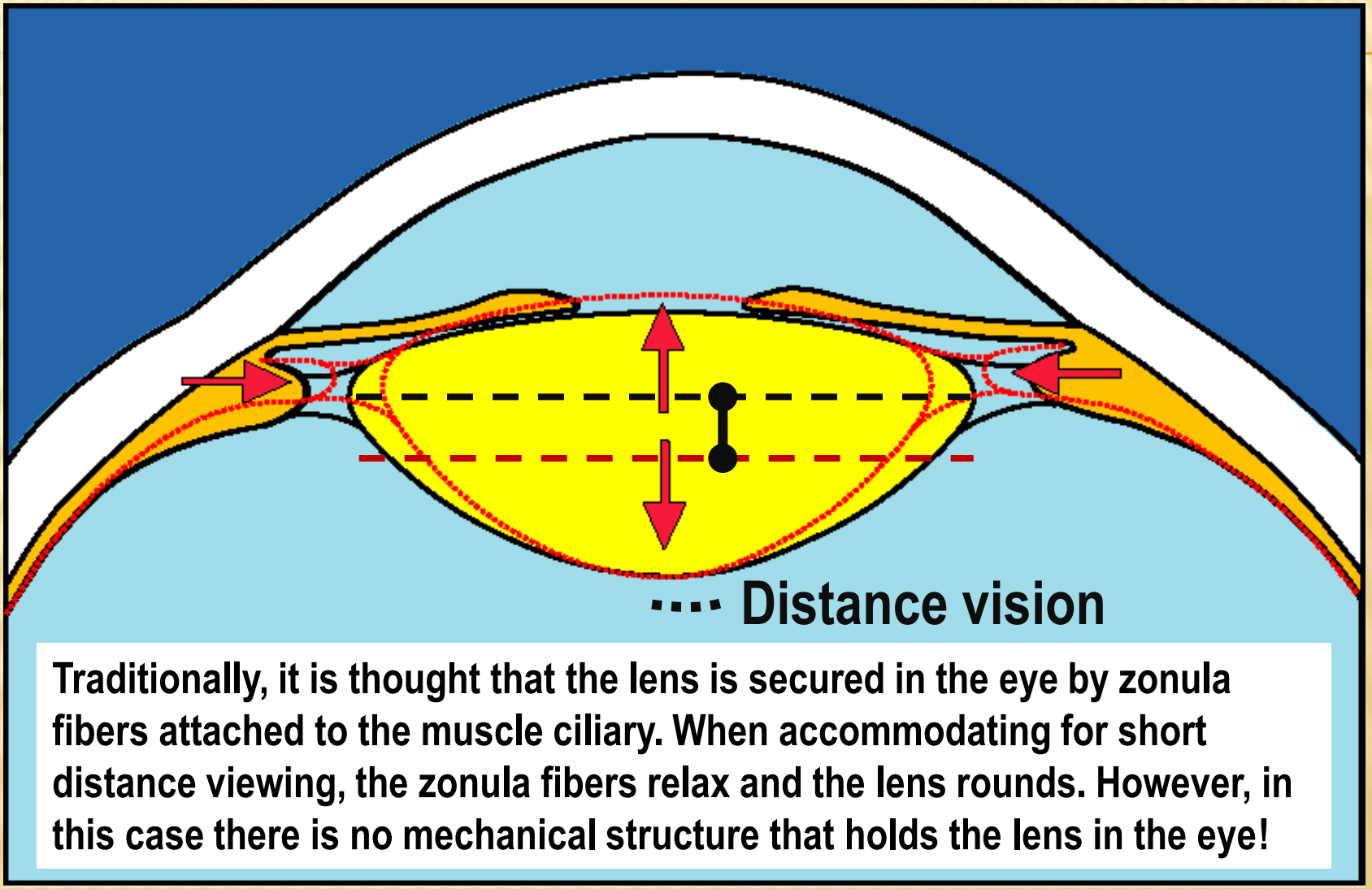
Helmholtz view is that the eye has a single mechanism of accommodation - accommodation through the lens - is traditionally considered an axiom. However, this is not the complete picture.

THE MECHANISM OF THE LENS ACCOMMODATION



According to traditional views, the Executive mechanism of accommodation are: **muscle ciliary, zonula and lens**. Vitreous Chamber and choroid are not included in these arrangements.

DEVELOPMENT OF THE THEORY OF ACCOMMODATION



Traditionally, it is thought that the lens is secured in the eye by zonula fibers attached to the muscle ciliary. When accommodating for short distance viewing, the zonula fibers relax and the lens rounds. However, in this case there is no mechanical structure that holds the lens in the eye!

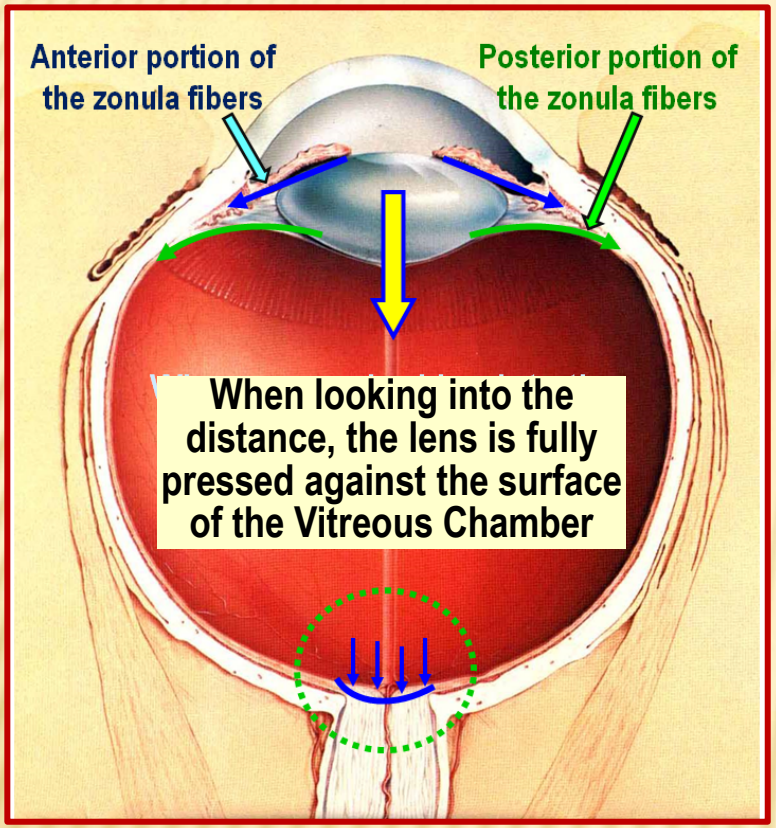
It should also be noted that the lens moves along the optic axis of the eyes during accommodation. But this is not taken into account.

DEVELOPMENT OF THE THEORY OF ACCOMMODATION

Actuators lens accommodation	
By H. Helmholtz (1855), j. Rohen (1969), R. Schachar (1999,2000), etc.	By O. Svetlova, I. Koshits, K. Kotlyar (1998.1999)
The only adjustment mechanism:	**The basic mechanism of accommodation:**
✓Active ciliary muscle ✓Zonula fibers ✓Capsule of lens **Do not participate:** ➢ Choroid ➢ Vitreous Chamber	✓Active ciliary muscle ✓Zonula fibers ✓Capsule of lens ✓Choroid ✓Vitreous Chamber Also involved additional mechanisms of the accommodation in the eye

Our new presentation develop an evolutionary theory of the lens accommodation by Helmholtz. In the eye has a lot of adjustment mechanisms. Their presence confirms the fact of maintaining accommodation in volume up to 2.5 D in eyes with intraocular lenses

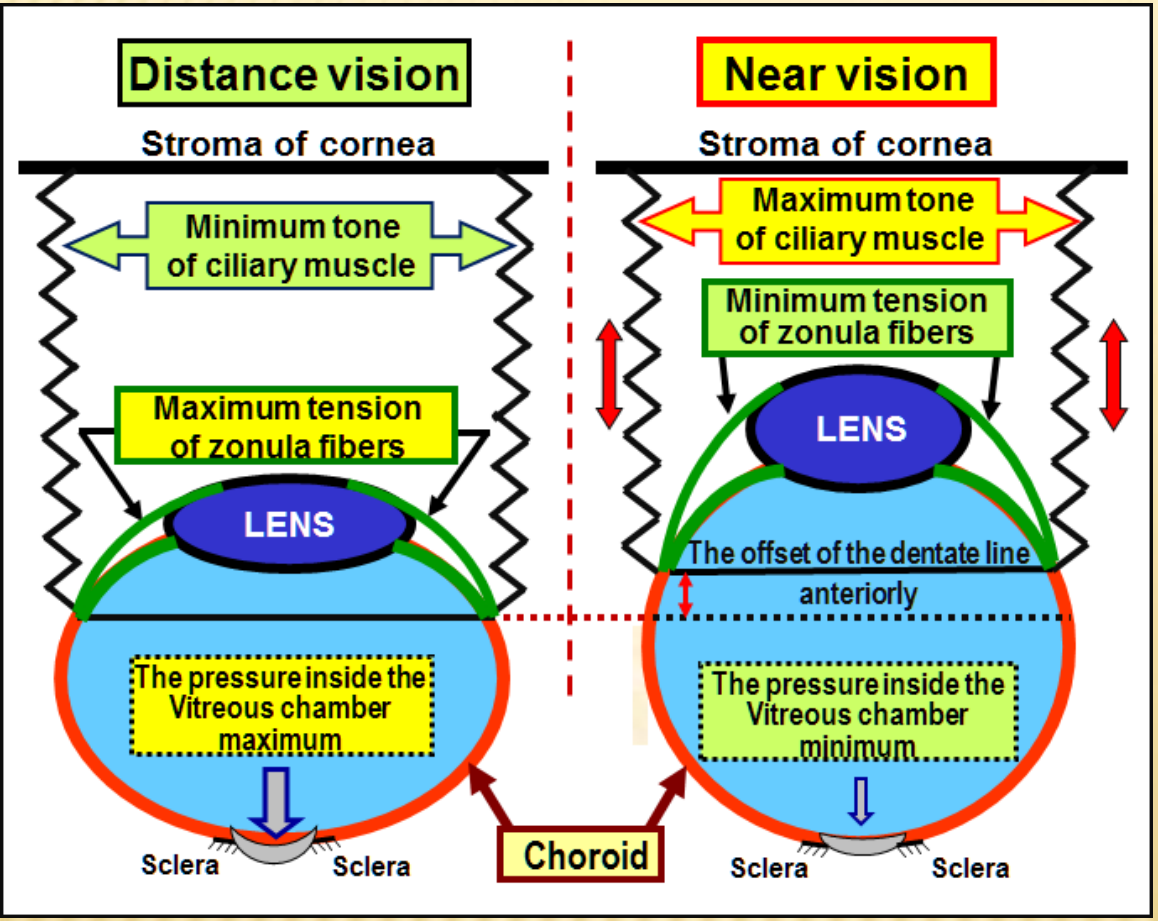
The joint work of the zonula fibers and Vitreous Chambers during accommodation



1. Using zonula fibers lens remains pressed against the Vitreous Chamber in all phases of accommodation.
2. The zonula fibers never relax fully.
3. When we are looking into the distance the lens is maximum pressed into the surface of the Vitreous Chamber.

When optical correction held not entirely, ciliary muscle relaxes, zonula fibers are stretched as much as possible, and the pressure in the Vitreous Chamber also becomes the maximum. This increases the volume of the excavation by some patients.

Actuators of the lens accommodation, which are consistent with the laws of mechanics



Increased tonus of the muscle ciliary moves anteriorly rack line of the choroid, weakens the tension of zonula fibers, allowing lens capsule to become more circular and displaced anteriorly.

The zonula fibers never relax fully. In all phases of accommodation lens is pinned to the Vitreous Chamber. This allows have amortize oscillations of the lens and to ensure its reliable anchoring in the eye.

SV 18

Anatomical structure of the zonula apparatus

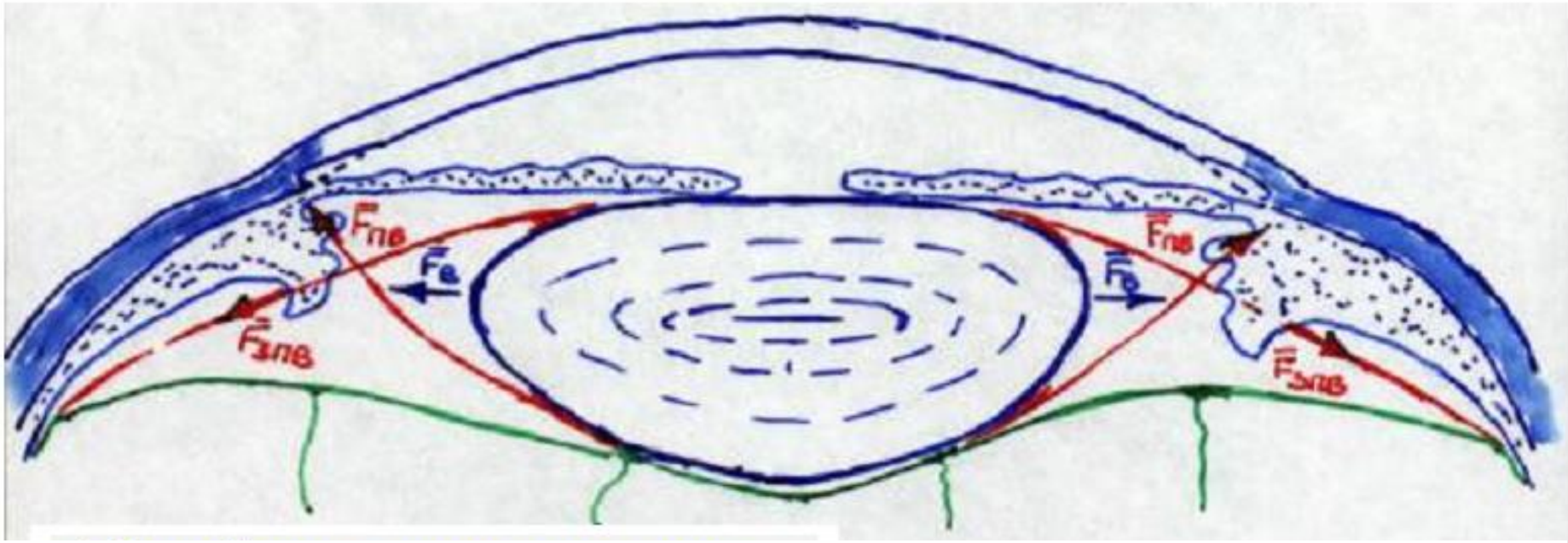
Traditional attitudes today have such features.
The zonula apparatus is involved in the process of accommodation as follows:

1. **The zonula fibers are attached to the muscle ciliary, which stretches through them, the capsule of the lens when performing visual work at a distance.**
2. **Front portion of the zonula fibers and rear portion of the zonula fibers intersect each other.**
3. **When you run a Visual work at close range The zonula fibers relax and even experience sagging.**
4. **Vitreous Chamber and choroid do not participate in the accommodation.**

All of these views are inconsistent with the laws of mechanics.

Intersection of the zonula fibers. It is a traditional but erroneous view. This view is still used for mechanical and optical calculations of intraocular lenses.

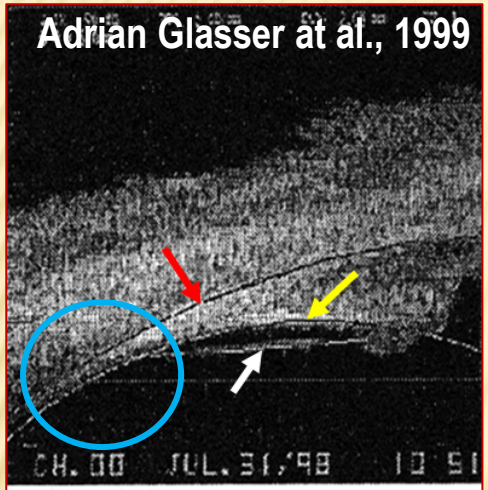
The intersection portions of the fibers. Lens held in elastic suspension. When the fibers were relaxation this Lens practically not fixed in the eye! Entrenchment of the lens in the eye is contrary to the laws of mechanics.



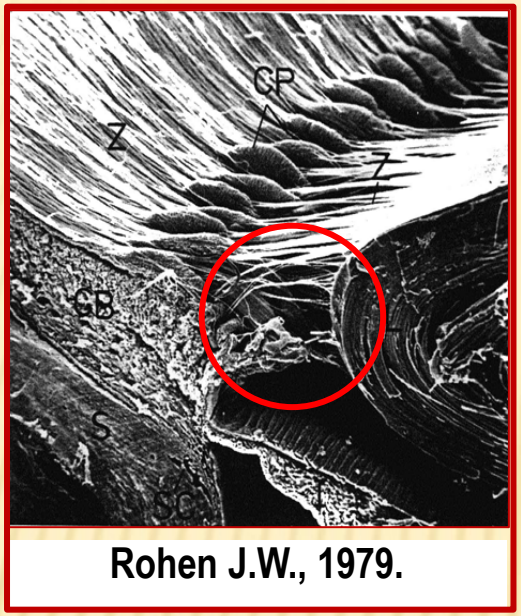
The wrong view!

1. Kotliar K.E., Svetlova O.V., Skoblikov A.S., Smolnikov B.A. **Biomechanical modeling of the accommodative system based on some contemporary conceptions of lens supporting apparatus functioning**.- Vision Science and Its Applications.- Santa Fe,1999, Optical Society of America, p. 156-164.
2. Svetlova O.V., Koshitz I.N., Krylova I.S., Kotliar K.E., Smolnikov B.A. **Further elaboration of the Helmholtz conception of the accommodation on the base of biomechanical analysis of the contemporary clinical observations.-** Acta of Bioengineering and Biomechanics, Wroclaw 2002.-vol.4.-Suppl.1:719.

Scanning electron microscopic studies of the zonular apparatus in human and monkey eyes. The intersection of fibers of the zonular apparatus is missing.

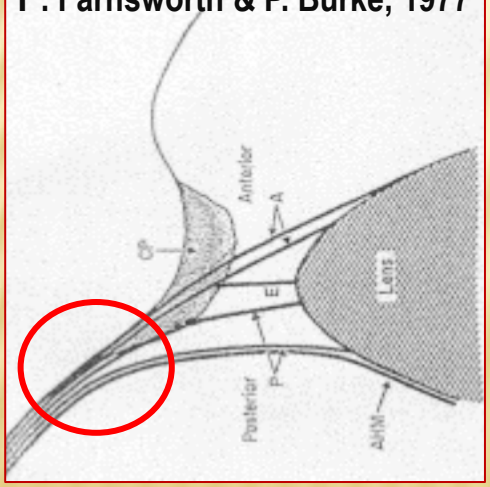


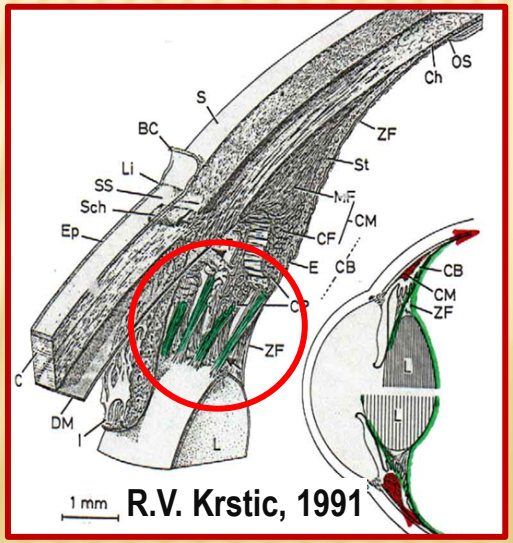
Overlay shows geometrical outline of ciliary muscle and zonular fibers.



Rohen J.W., 1979.

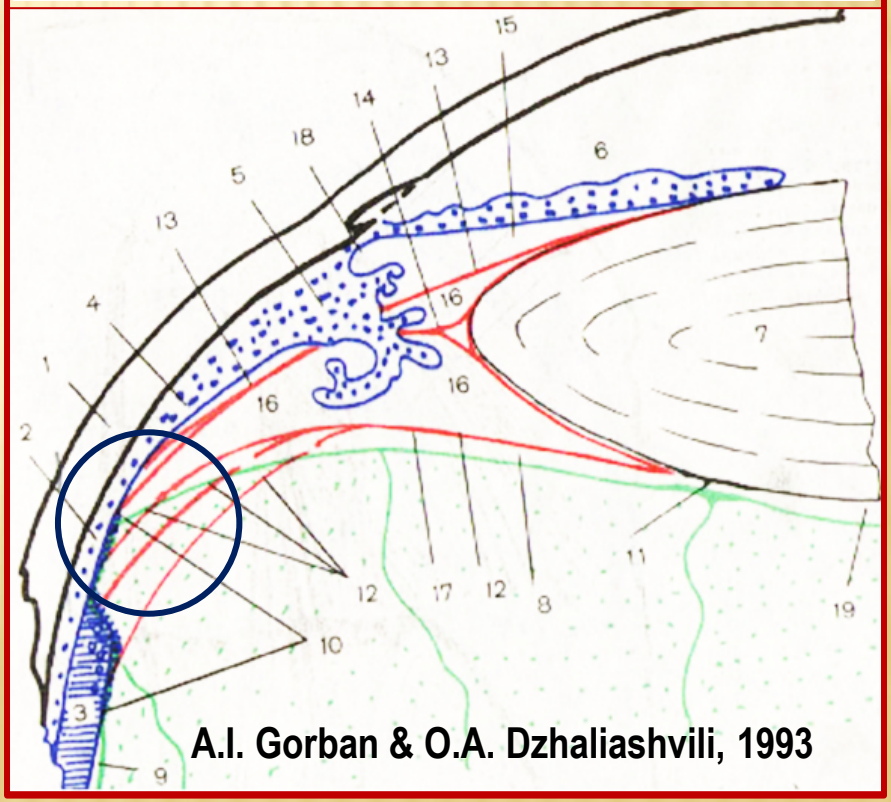
P. Farnsworth & P. Burke, 1977



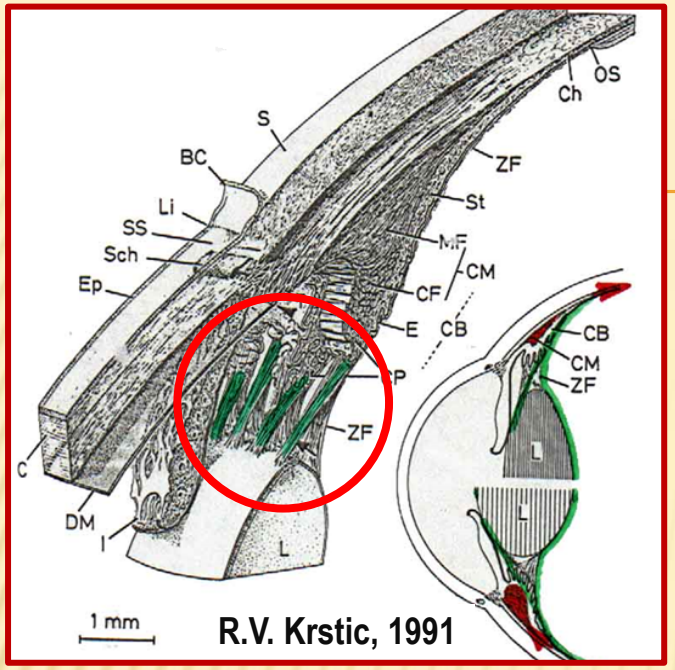


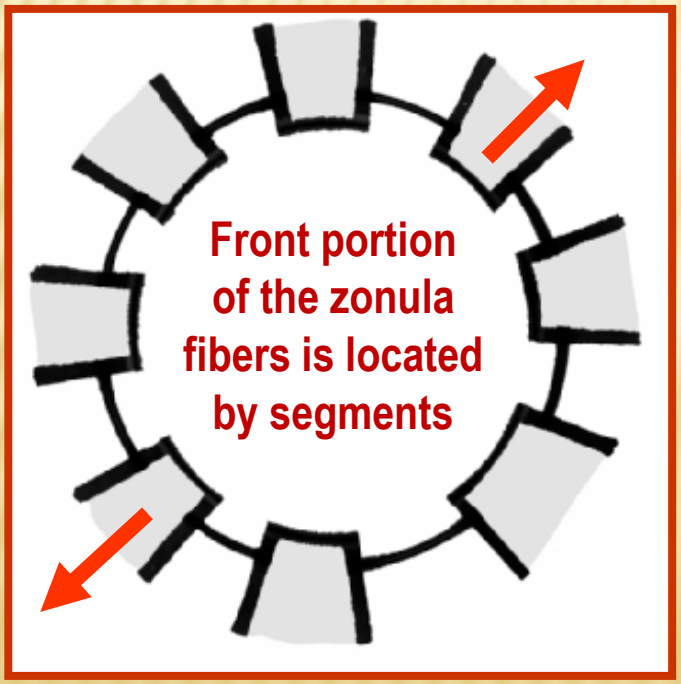
R.V. Krstic, 1991

Correct knowledge about the location and course of the fibers of the zonular apparatus without crossing.



A.I. Gorban & O.A. Dzhaliashvili, 1993





Anatomy of the zonular apparatus in human and monkey eyes allows to provide accommodation, as well as the uneven level of astigmatism.

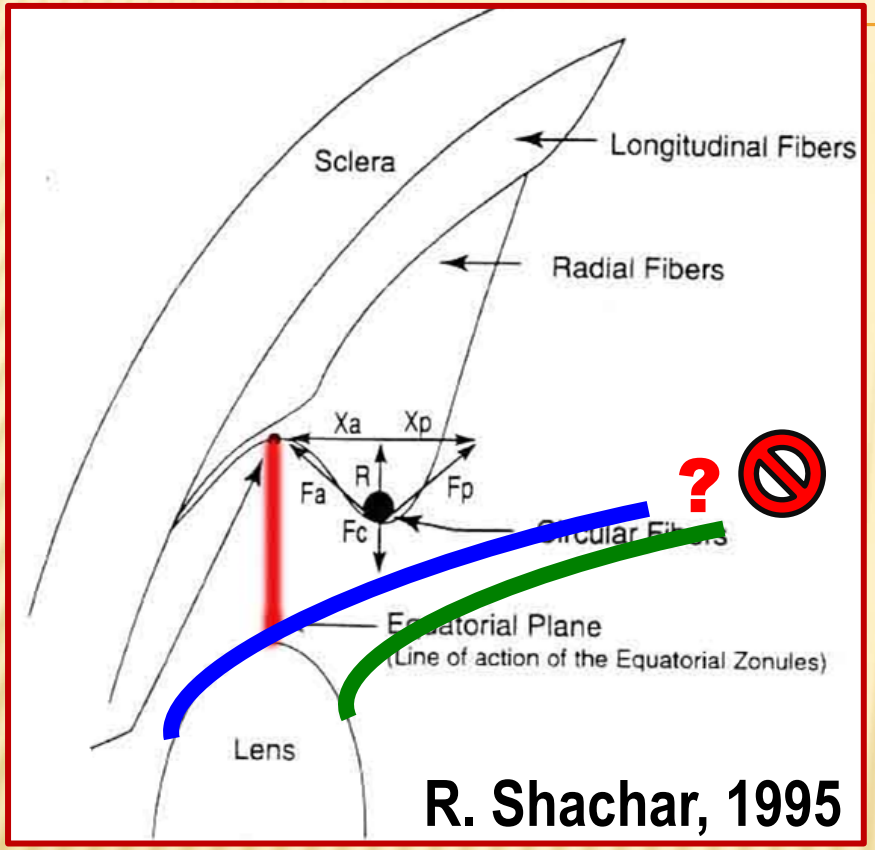
Anterior portion of the zonula fibers is attached to the lens capsule in the form of individual segments.

This allows the eye to partially reverse the astigmatism, and also provides the possibility of uneven accommodation in different meridians.

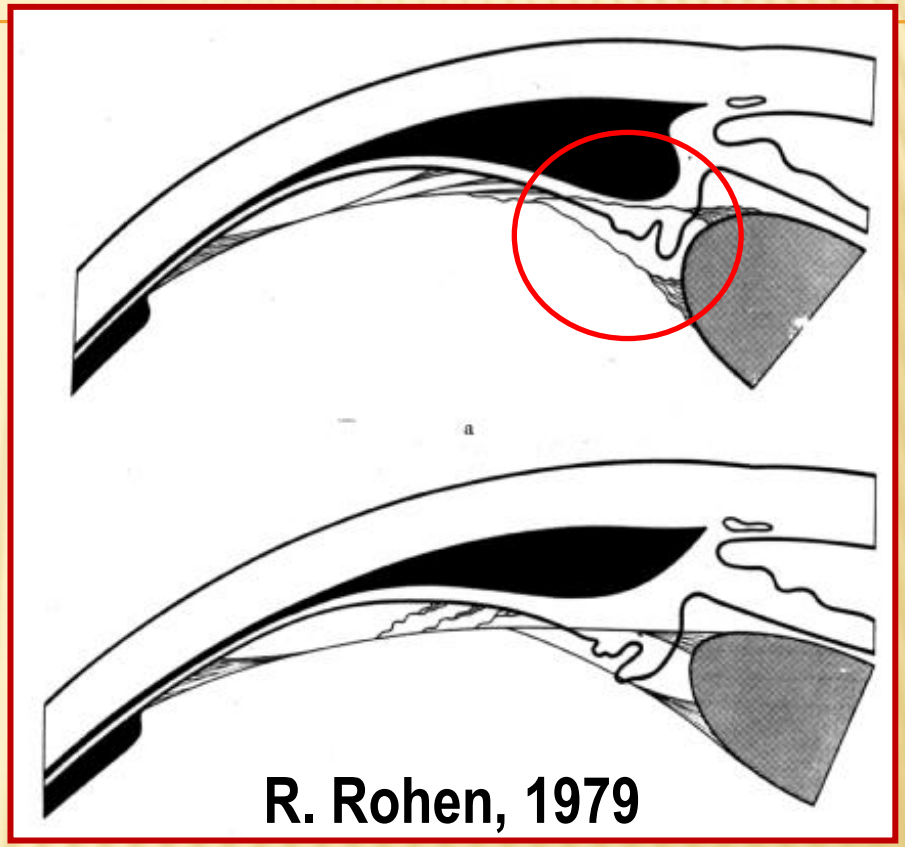
Our own presentation on the work of the zonula apparatus of the eye. They are fully adequate to the laws of mechanics

- Front and rear portions of the zonula fibers are powerful and able to withstand heavy shock loads.
- These portions of fibers attached to the rear of the dentate line of the choroid, and attached to the front lens bag.
- These portions of fibers not attached directly to the muscle ciliary.
- Anterior portion of the zonula fibers withheld using very fine efferent fibers between spikes of the muscle ciliary, providing them with the necessary anatomical distortion.
- The rear portion of the zonula fibers cover the Vitreous Chamber in the form of a glassy Web, creating mechanical system with high resistance to dynamic loads.
- The thin Equatorial fibers located on Equator of the lens capsule and attached between spikes of the muscle ciliary. They evenly stretch the lens capsule during minimum tonus muscle ciliary. These fibers do not work on accommodation, and are designed to hold the weight of the movable lens centered on the optical axis.

Our own presentation on the work of the zonula apparatus of the eye. They are fully adequate to the laws of mechanics



R. Shachar, 1995



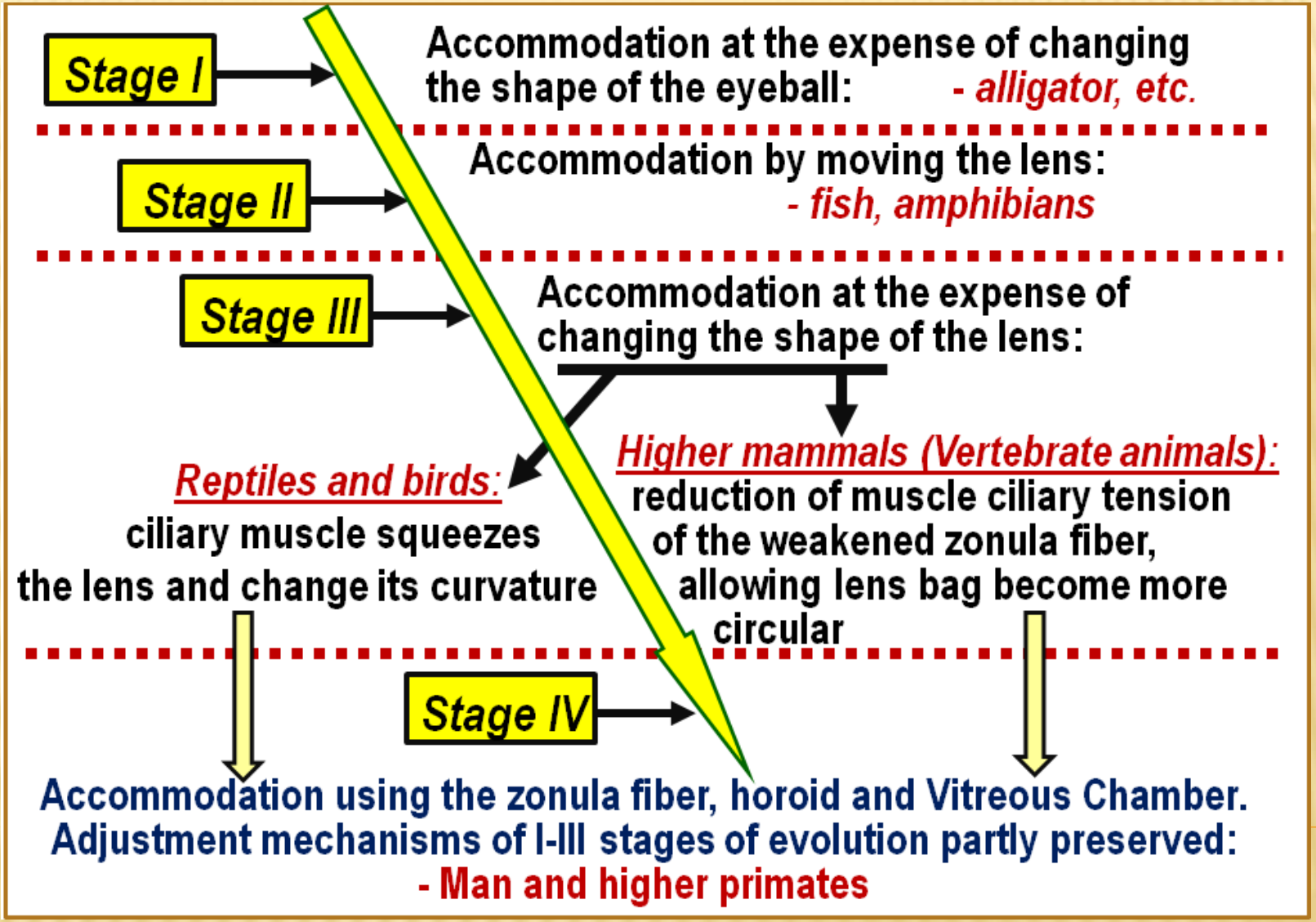
R. Rohen, 1979

It is now possible to understand why the theory of accommodation R. Rohen and R. Shahar are not adequate laws of mechanics.

Kotliar K.E., Svetlova O.V., Skoblikov A.S., Smolnikov B.A. Biomechanical modeling of the accommodative system based on some contemporary conceptions of lens supporting apparatus functioning. Vision Science and Its Applications. Santa Fe, Optical Society of America, 1999, p. 156-16/

Additional mechanisms of accommodation

The evolution of mechanisms of accommodation

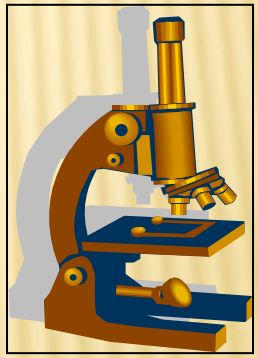


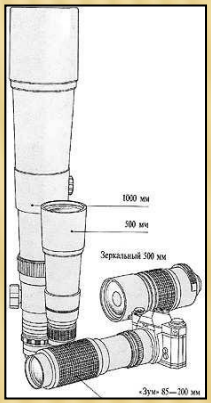
Evolutionary development of apparatus in accommodation of birds, animal and reptiles allowed to apply all these mechanisms to in the human eye.

Ways to create a sharp image

1. Way to screen movement:

2. Way to modify the properties of refracting force of optical system



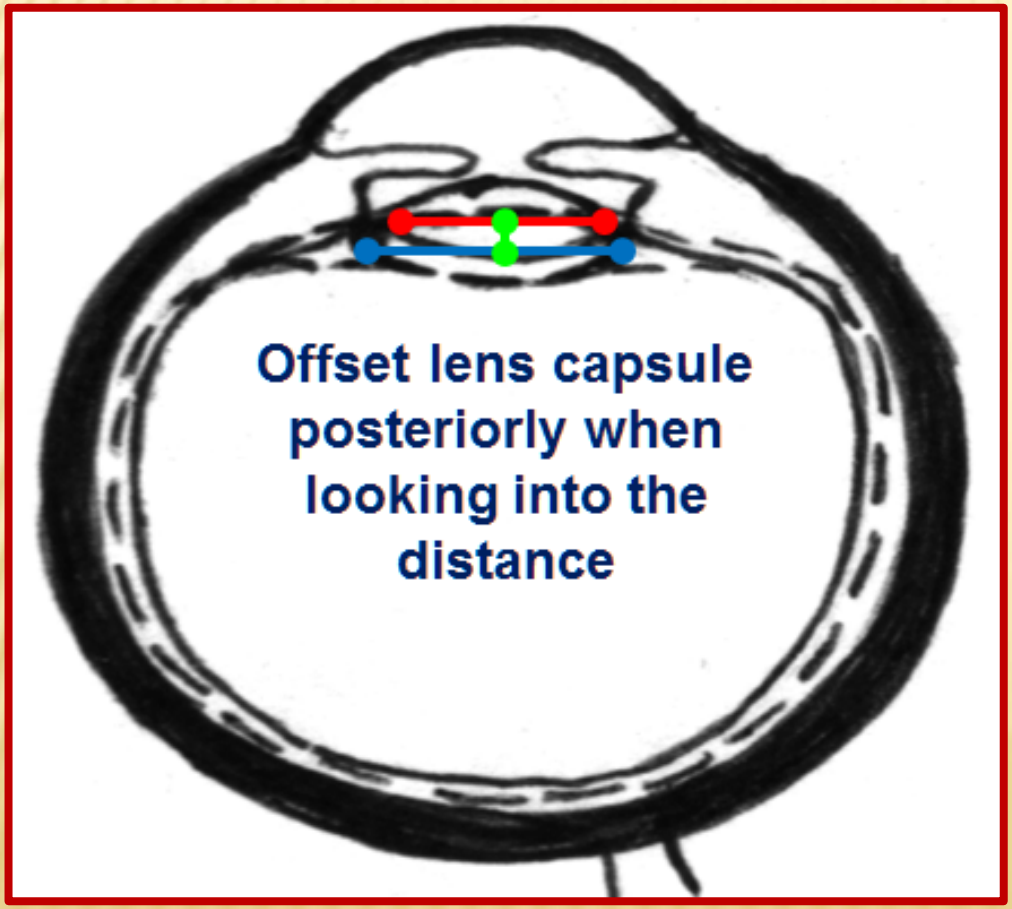


3.Way to change the depth of field:

Aperture in the Camera lens, Spyglass, Binoculars, Optical sights, etc.

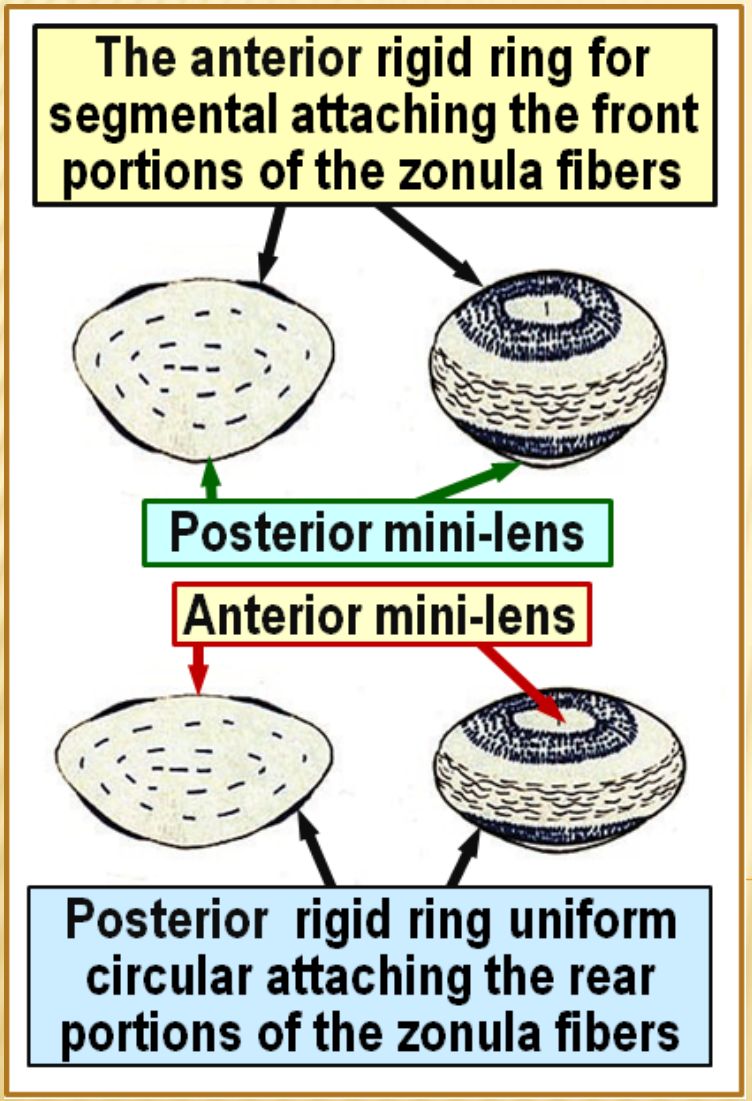
All three of these methods are implemented in the human eye!

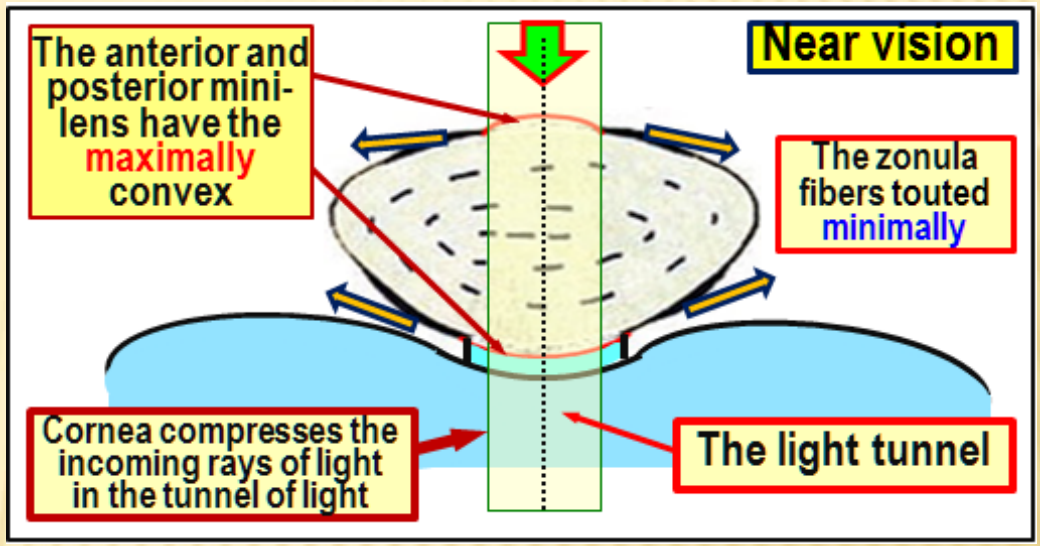
Examples of additional accommodation mechanisms in the human eye

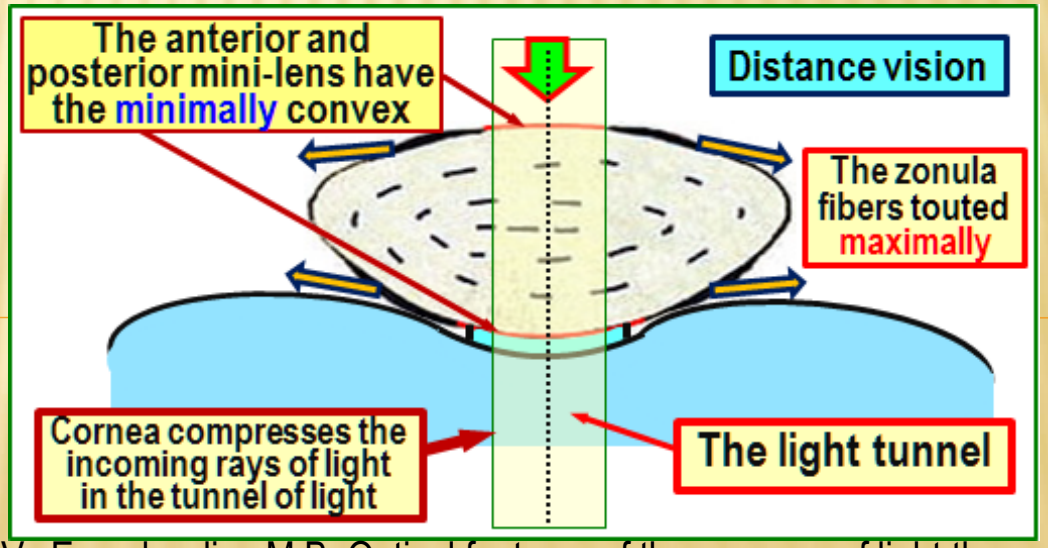


Mechanism of Change of the focus location

Recently we have found a new supplementary of the lens mechanism accommodation : modified refractive power with the help of the anterior and posterior mini-lenses.

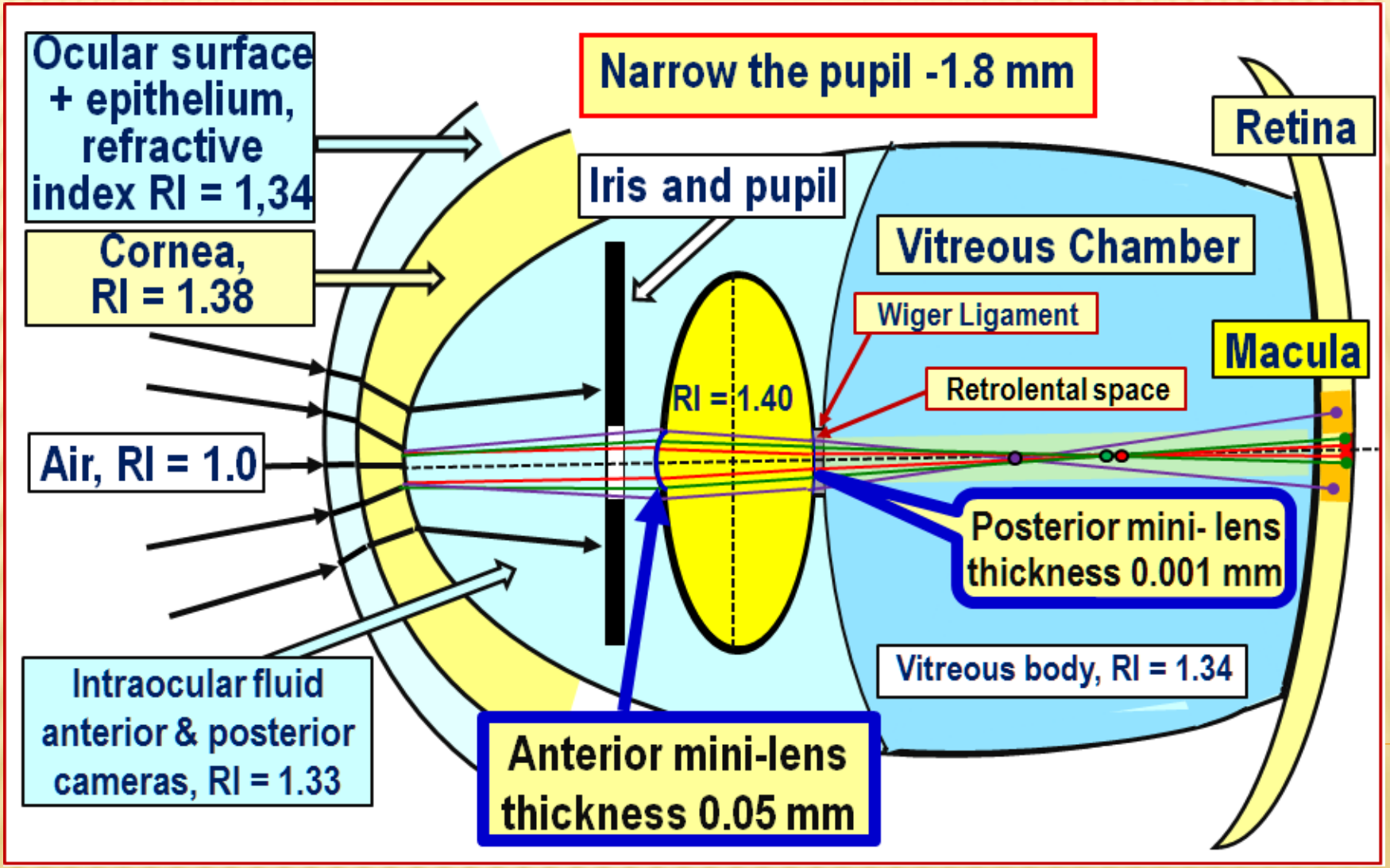






Koshits I.N., Svetlova O.V., Guseva M.G., Pevko D.V., Egemberdiev M.B. Optical features of the passage of light through the refractive structures of the eye.- *Ophthalmic journal*,2017.- 4 (477): 60-73.

When you narrow the pupil in the eye refraction of the light rays is as follows:



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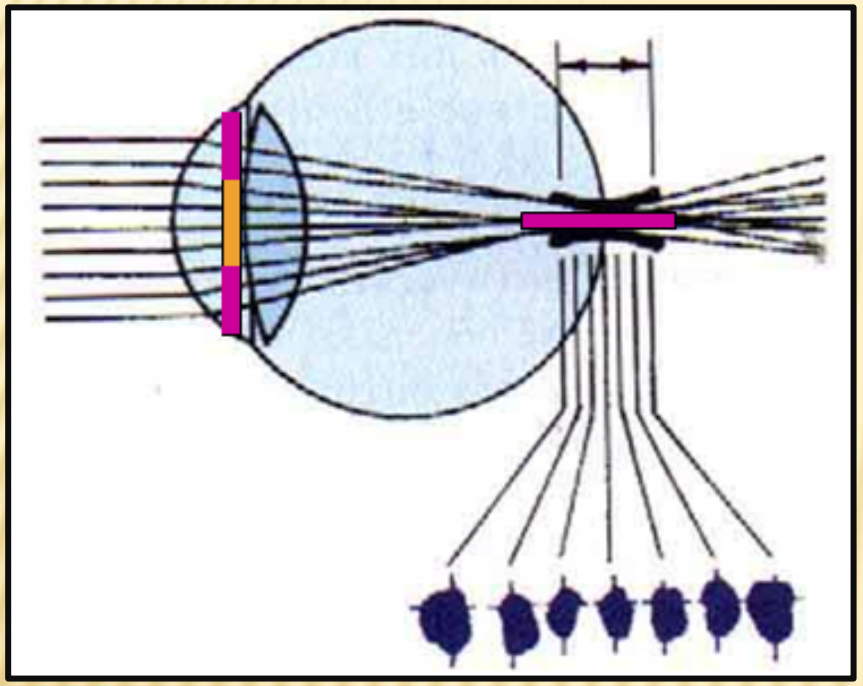
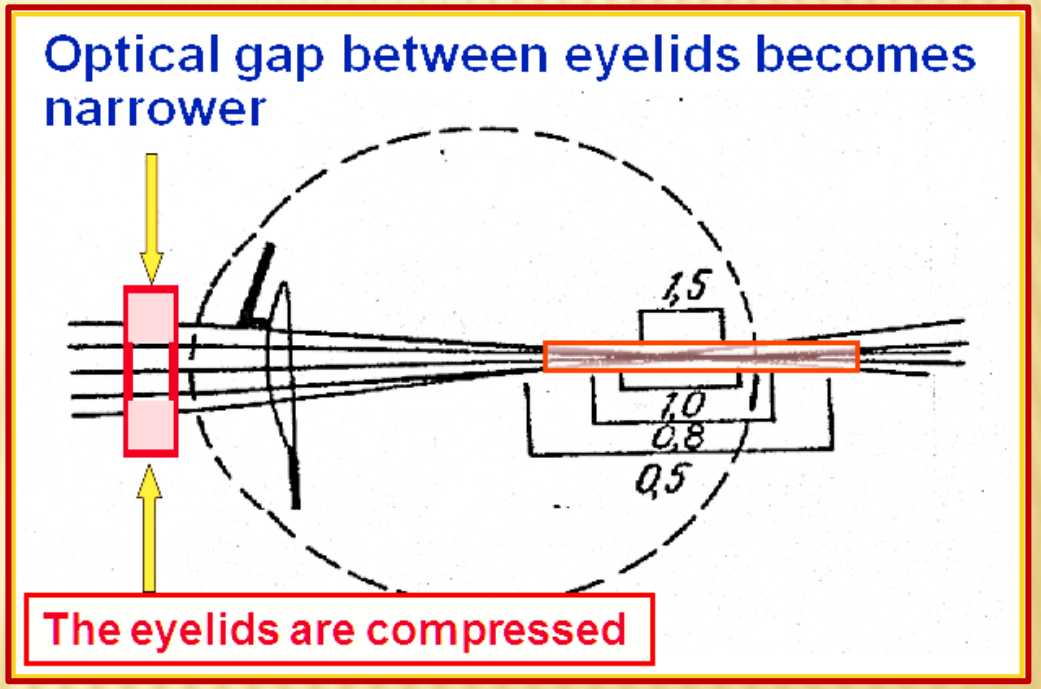
Additional accommodation mechanisms that increase the depth of field

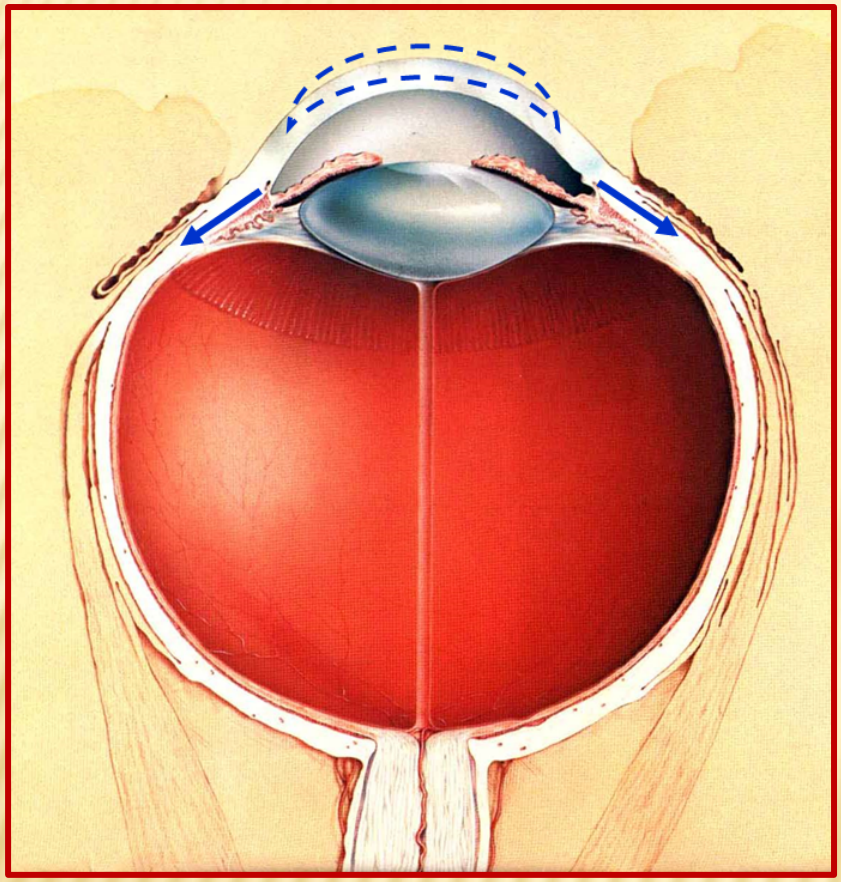




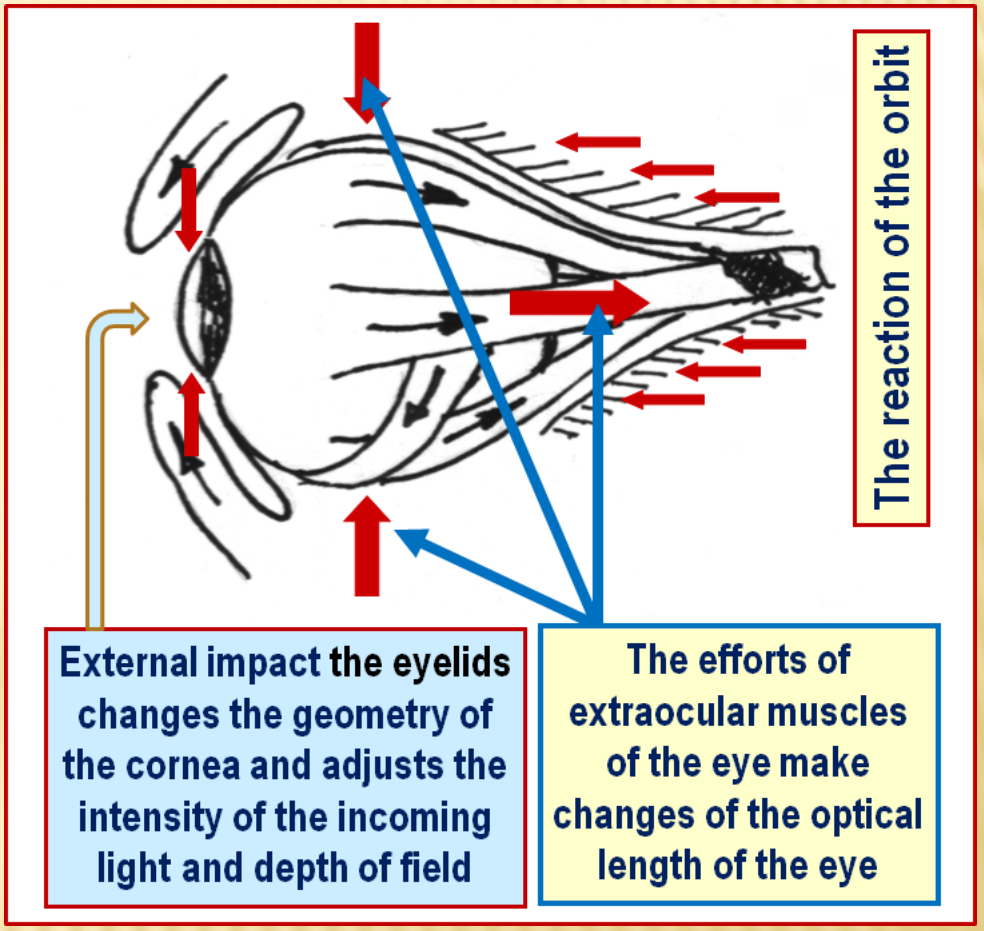
Mechanism of decrease pupil diameter

Mechanism of decrease optical slits between the eyelids

Examples of additional accommodation mechanisms in the human eye that alter the geometry Forms of the cornea and sclera



The mechanism of the eye optical changes due to warping of the cornea at the maximum tone of the muscle ciliary.



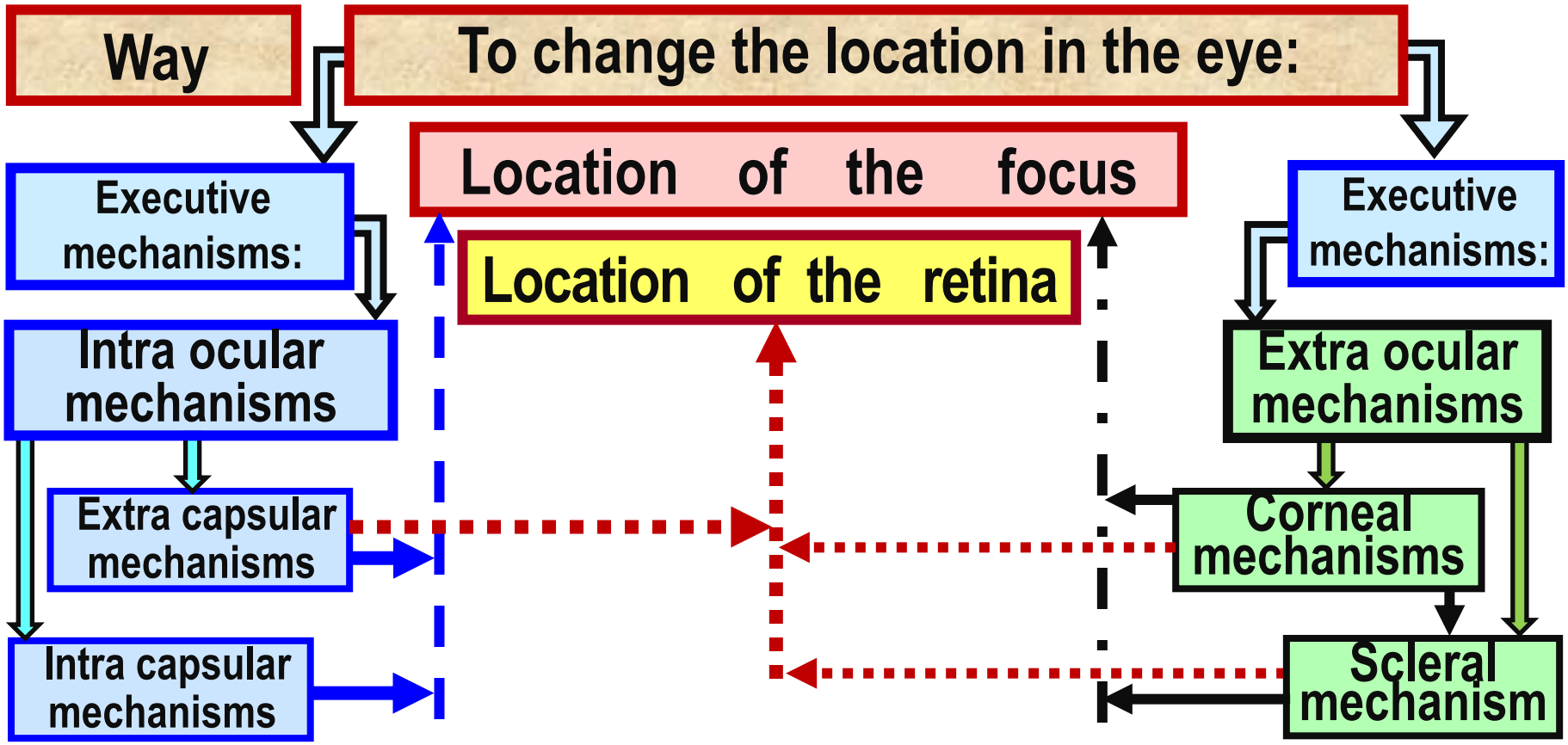
The mechanism of the eye optical length changes due to changes in the shape of an eyeball.

Our own classification of executive mechanism of accommodation

The purpose of the providing quality reception of images

Opportunities

Helmholtz mechanism and additional mechanisms of accommodation



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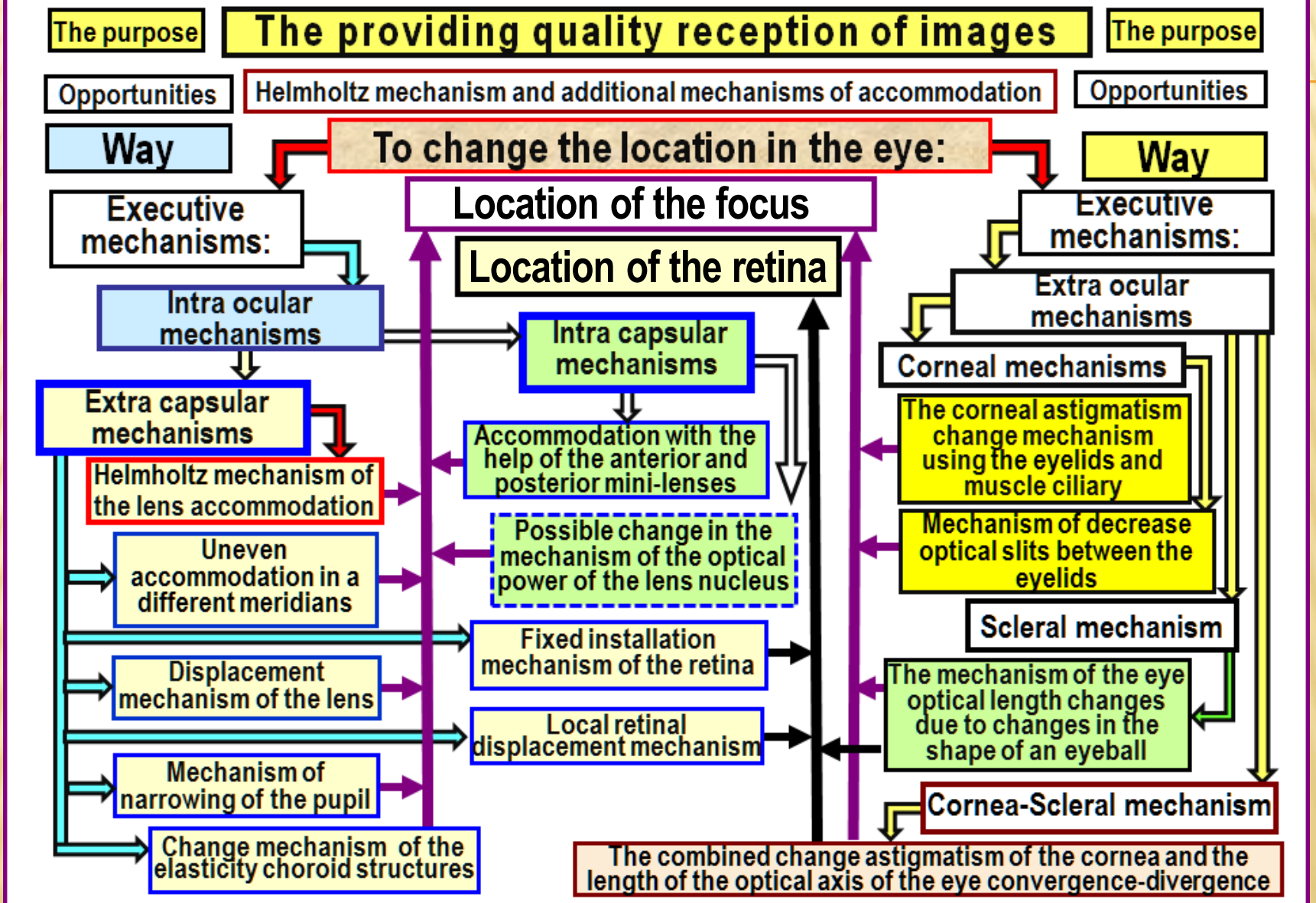

To stady this scheme in more detail posible on a site of the Congress.

Thanks for your attention!