

# Optical apparatus of the eye, oculomotor muscles, eye movements

The eye consists of: cornea, conjunctiva, aqueous humor, lens, vitreous. We recognize two axes in the eye - **visual** (pointing through the center of the lens to the fovea) and **optical** (pointing through the center of the lens to a place about  $5^\circ$  [1] away from the fovea to the left of the right eye and to the right of the left eye).

## Basic data [1]

- Perceived light: 400 to 700 nm;
- Intraocular pressure: 2.0 to 2.9 kPa (15 to 22 torr);
- Refractive power of the lens: the reciprocal of the focal length in meters, i.e. 1 D corresponds.

## Optical apparatus of the eye

The eye contains a **light-refracting** and **light-receiving** apparatus. The refracting apparatus consists of the cornea and the lens, as well as the aqueous humor and vitreous humor. **The optical power of the unaccommodated eye** is approximately + 59 D, of which 43 D belongs to the cornea and 16-20 D to the lens. The optical power of the lens is variable. During accommodation, the eye does not have an optical power of 59 D.

## Visual axis of the eye

The visual axis of the eye is a straight line that connects the optical center of the eye with the yellow spot. It makes an angle of about  $5^\circ$  with the optical axis of the centered system of the eye, that is, the yellow spot is not in the image focus of the eye, but is deviated from it by about 1.5 mm temporally.

## Cornea

The cornea is approximately spherical in shape. It separates the internal environment of the eye from the surrounding air environment (with a refractive index of 1), which makes it the most efficient of the entire refractive system. **The refractive index of the cornea** is 1.37.

## Lentil

**The lens** is a crystal clear structure whose optical power is variable due to its accommodation capacity. Due to the heterogeneous structure of the lens, there is no uniform index of refraction. For practical purposes, only the average refractive index of the whole lens of 1.42 is used. The passage of the ray through the lens is therefore not straight.

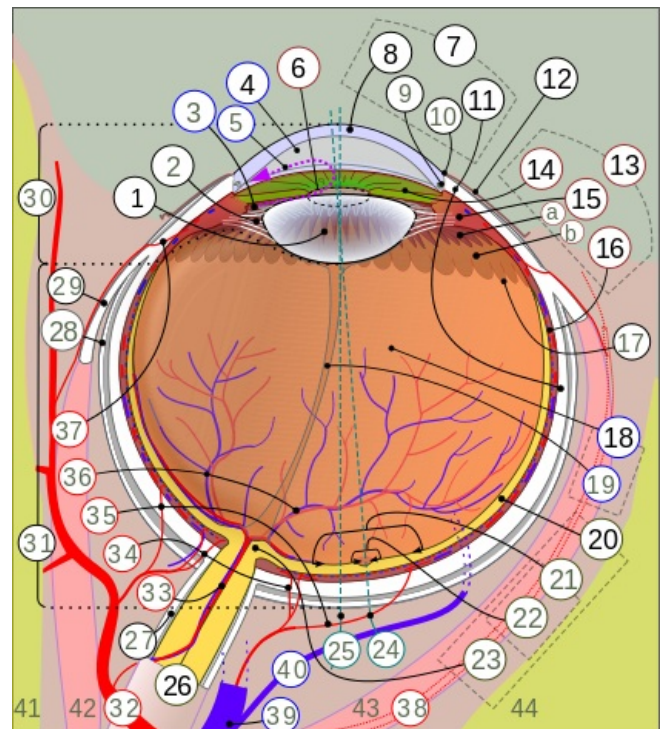
**The ciliary apparatus**, on which the lens is suspended, has the ability to mechanically change the curvature of the front and back of the lens, thereby changing its optical power. When looking up close, muscle contractions loosen the fibers of the suspensory apparatus of the lens, it bulges and its refractive index increases.

## Accommodation ability of the lens

The range of accommodation ability of the lens is determined by the so-called near and far points.

## Near point

The near point (*punctum proximum*) is the **nearest** point that the eye sees sharply at **maximum** accommodation. With age, the elasticity of the lens decreases and therefore the accommodation capacity, and the near point moves away. In a ten-year-old child, the accommodative width is about 15 D and the near point is 7 cm in front of the eye. In a 20-year-old person, an emmetrope, the accommodative width is reduced to 10 D (the near point is 10 cm in front of the eye). In an adult younger person, an emmetrope, it is at a distance of 25 cm in front of the eye



(accommodative width 4 D), which is the so-called conventional visual distance. When the near point gets over 25 cm in front of the eye, problems with near accommodation begin to appear, especially when reading. This defect is called **presbyopia**. Around the age of 70, the lens loses its ability to accommodate and the accommodation width is 0 D.

## Far point

The far point (*punctum remotum*) is the farthest point that the eye can see clearly without accommodation, and in a healthy eye it is at infinity (practically, we consider a distance of 5 m as infinity for the eye).

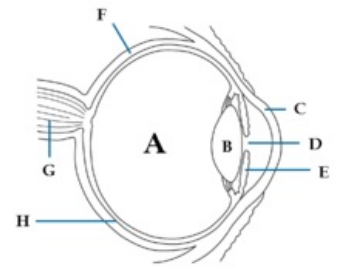
## Oculomotor muscles - movements of the eye

The **oculomotor muscles** are the muscles that ensure **the movements of the eyeball**.

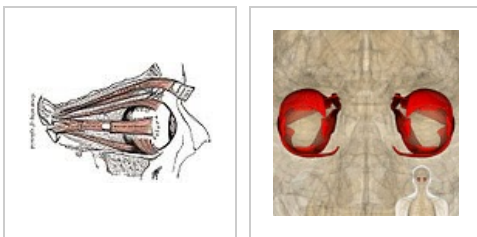
According to the course of the muscle bundles, we divide them into:

- **direct,**
- **oblique.**

The common **origin** of the oculomotor muscles is a circular tendon located at the tip of the orbit - **anulus tendineus communis**.

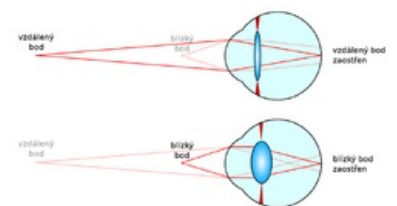


A - vitreous; B - lens; C - cornea; D - pupil; E - iris; F - sclera; G - optic nerve; H - retina



Lateral view of the right eye and oculomotor muscles

3D projection of oculomotor muscles



Accommodation of the eye - image display on the retina

## Musculi recti

**Attachments** of individual muscles are located in each quadrant of the **bulb**. The name corresponds to the position of the muscle.

The third cranial nerve - **the oculomotor nerve** provides **innervation** to all rectus muscles, with the exception of the **rectus lateralis muscle**, which already falls under **the abducens nerve**.

- **m. rectus superior:** n. III.;
- **m. rectus inferior:** n. III.;
- **m. rectus medialis:** n. III.;
- **m. rectus lateralis:** n. VI..

## Musculi obliqui

The **oblique muscles** have a common beginning with the rectus muscles, but their attachments and courses are different.

Innervation is provided by **the trochlearis nerve** and **the oculomotor nerve**.

- **m. obliquus superior:** n. IV.;
- **m. obliquus inferior:** n. III..

## Oculomotor muscle and its function

Nerve		Innervated muscles	Physiological function
III - the oculomotor nerve	parasympathetic part	m. sphincter pupillae, m. ciliaris	narrowing of the pupil, accommodation
	motor fibers	m. rectus medialis, superior et inferior, m. obliquus inferior	movement of the eye nasally, up, down
		m. levator palpebrae superioris	lid elevation, open eye slit
IV - the trochlearis nerve		m. obliquus bulbi superior	movement of the bulb down and out
VI - the abducens nerve		m. rectus lateralis	abduction of the eye
sympaticus		m. dilatator pupillae, m. tarsalis	pupil dilatation, eyelid tone

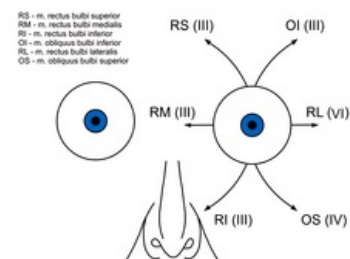


Diagram of the function of oculomotor muscles

## Links

### Related articles

- Oculomotor muscles
- Optical apparatus of the eye
- Visual pathway
- Eye (histology)
- Eye (biophysics)

### References

1. TROJAN, Stanislav. *Lékařská fyziologie*. Vyd. 4., přeprac. a dopl. Praha: Grada, 2003. ISBN 80-247-0512-5.
2. *Okohybné poruchy/PGS/diagnostika* [online]. c2010 [citováno 21. 11. 2022]. Dostupný z WWW: <[https://www.wikiskripta.eu/index.php?title=Okohybn%C3%A9\\_poruchy/PGS/diagnostika&oldid=52613](https://www.wikiskripta.eu/index.php?title=Okohybn%C3%A9_poruchy/PGS/diagnostika&oldid=52613)>

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