

# Visual pathway

## Visual pathway

The **visual pathway** is a multisynaptic, four-neuron sensory pathway, belonging to the sensory pathways. The first three neurons of the visual pathway are located in the retinal ganglion cells.

The **first neurons** are converted into special **light-harvesting cells (photoreceptors)** and are of two types: rods and cones.

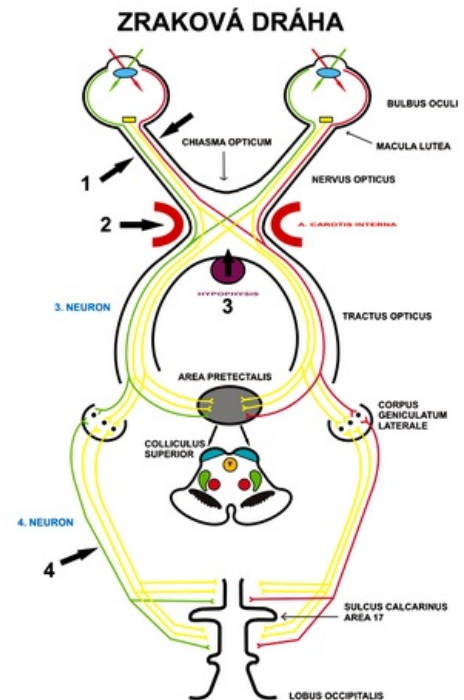
The **second neurons** are collectively referred to as the *ganglion retinae*.

The **third neurons** are collectively referred to as *ganglion opticum*, have long axons that run through the *nervus opticus* and on to the *corpus geniculatum laterale* of the **thalamus**.

The **fourth neurons** are located in the *corpus geniculatum laterale* and their axons run as a **tractus geniculocorticalis** to the cortex of the occipital lobe.

The axons of some third neurons detach during the course of the pathway to form additional connections and branches, controlling, for example, the miosis and mydriasis, oculomotor functions, retrieval movements, and others.

The main function of the optic pathway is the transmission of the image captured by the light-harvesting cells, which is made possible by its retinotopic arrangement in all its parts.



## The course of the visual pathway

- The **first neurons** are **special luminous cells** whose dendrite is transformed into a luminous process that converts light stimuli into nerve signals; they are located in the outermost layer of the retina (meaning away from the *corpus vitreum*), and their short axons point inwards, where they connect to the dendrites of bipolar neurons.
- The **second neurons** are bipolar neurons, collectively called *ganglion retinae*. Their dendrites are connected to the axons of the luminous cells, and the axons lead to the dendrites of the ganglion cells.
- The **third neurons** are **ganglion cells** collectively referred to as *ganglion opticum*. Three types of ganglion cells have been described - parasol cells, midget cells and bistratified cells. Their axons run along the inner circumference of the bulb and converge at the discus nervi optica, where they penetrate the bulb wall. After leaving the eye, they acquire a myelin sheath and form the **nervus opticus**, which is covered on the surface by the meninges. The myelin sheath is formed by the oligodendroglia (according to some authors, the n. opticus is therefore not a peripheral nerve in the true sense of the word, due to its myelin sheath). After passing through the canalis opticus, the two optic nerves join to form the **chiasma opticum**, in which axons originating from the medial parts of the retina and some axons from the macula cross. The axons originating from the lower nasal (medial) quadrants of the retina form the so-called Willebrand's knee in the chiasma opticum, because at their crossing they slightly run into the contralateral n. opticus (therefore, in case of a complete lesion of the n. opticus just before the chiasma, not only amaurosis of the ipsilateral eye, but also scotoma of the upper temporal quadrant of the contralateral visual field will occur). From the chiasma opticum, the right and left tractus opticus continues, whose fibers lead to the corpus geniculatum laterale. There they terminate in six layers of gray matter, designated numbers 1-6. Layers 1 and 2 form the so-called magnocellular cells, the remaining layers the parvocellular cells. Between these layers are the interlaminar spaces, collectively termed the koniocellular system. Parasol ganglion cells (see above) terminate their axons in the magnocellular system, midget cells in the parvocellular system, and bistratified cells in the koniocellular system. Layers 2, 3, 5 receive ipsilateral fibers, layers 1, 4, 6 receive contralateral fibers.

Towards the *corpus geniculatum laterale*, the *tractus opticus* divides into the thicker **radix lateralis**, which enters directly into the *corpus geniculatum laterale*, and the weaker **radix medialis**, which goes into the *brachium colliculi superioris* and some of whose fibres end in the *colliculus superior tecti*. Other fibres separate as the **radix optica mesencephalica**, which enters the area preectalis, and the **radix optica hypothalamica**, which terminates in the *nucleus supraopticus* and *suprachiasmaticus* of the *hypothalamus*.

- The **fourth neurons** are cells of the *corpus geniculatum laterale*. Their axons form the **tractus geniculocorticalis Gratioleti** (radiatio optica). In their course they divide into an upper and a lower part, the lower part running in the temporal lobe and at the beginning of its course forming the so-called Meyer's curve. The upper part of the fibres runs in the parietal lobe. Thus, all fibres run backwards and medially to the occipital lobe cortex, where they end in area 17, whose neurons form the so-called cortical image of the external world. Some fibres also terminate in area 18 and area 19 in the 2nd, 3rd and especially 4th layers of the cortex. The information transmitted by the magnocellular system answers the question **where** - object localization and motion detection, the parvocellular system is responsible for the fact **what** - structural image

## Branches from the visual pathway

### Pupillary reflex trajectory

The pupillary reflex pathway is connected to the *radix optica mesencephalica*, which goes to the area pretectalis, where the nuclei pretectales are located and divides into the pathway for the **miosis** and the pathway for the **mydriasis**. The pathway for the miosis continues to the parasympathetic *nucleus oculomotorius accessorius* (Edinger-Westphal nucleus). From there it follows the path of the **nervus oculomotorius** to the ganglion ciliare in the orbit and from there, after reconnection, to the *m. sphincter pupillae*. The pathway for the *mydriasis* is brought down to the RF mesencephalon, from where it descends through the reticulospinal pathways to the lateral horns of the spinal segment *C8* where the sympathetic ciliospinal centre is. From there the fibres lead to the superior cervical sympathetic ganglion and after reconnection further, along the arteries, to the *m. dilatator pupillae*.

### Trajectory of accommodation

The eye's accommodative pathway is the same as the pupillary reflex pathway. Switching from the visual pathway takes place in the *nucleus interstitialis* (Cajal's nucleus). From there it continues to the *nucleus oculomotorius accessorius* and then to the *m. ciliaris*.

### Eye convergence path

The convergence pathway of the eyes is reconnected from the visual pathway in the *nucleus interstitialis*. It is further connected by the *fasciculus longitudinalis medialis* system to the nuclei of the oculomotor muscles that provide convergence.

### Tectal visual circuit

The tectal visual circuit refers to the pathways that enable motor responses to visual stimuli. They branch from the visual pathway to the *colliculus superior tecta*, where visual stimuli are processed and reconnected to the motor descending pathways: the *tractus tectospinalis*, *tractus tectoreticulospinalis*, *tractus tectonuclearis*, and *tractus tectoreticulonuclearis*. And also the tractus tectocerebellaris for visual and proprioceptive coordination.

### Visual pathway functions

The main function of the visual pathway is the transfer of the image of the external world, captured by the luminous cells, to the cerebral cortex, which is made possible by the precise retinotopic arrangement along its entire length. Branches from the optic pathway then allow the control of reflexes such as miosis and mydriasis, and various oculomotor movements as well as motor movements of the whole body. The hypothalamic branch affects autonomic functions and the control of circadian rhythms.

## References

### Related articles

- Limb muscles
- Eye (histology)
- Eye (biophysics)

### External links

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- AMBLER, Zdeněk. *Klinická neurologie*. 2. vydání. Praha : Triton, 2008. 976 s. ISBN 978-80-7387-157-4.