lateral geniculate nucleus

what role does this relay center play in the visual pathway?

The lateral geniculate nucleus (LGN) is placed in a prominent position in the early visual pathway. It sits between the retina and the visual cortex, acting as a relay between the two. Inserting a microelectrode into the LGN reveals that the receptive fields are very similar to those in the retina. This is surprising because the LGN does not only receive input from the ganglion cells of the retina alone. About 80 % of the excitatory input to the LGN is feedback from the visual cortex. One would therefore expect the LGN to be more heavily influenced by visual cortex and the response not so similar to the input from retina. The role of this massive feedback has not been clearly identified, and the functional role of the LGN is therefore poorly understood.

A combination of experimental studies and computer simulations of the network will be key components in understanding the functions of LGN. The experimental work includes extracellular recordings and optogenetics. The simulations are performed with computational tools such as NEURON.

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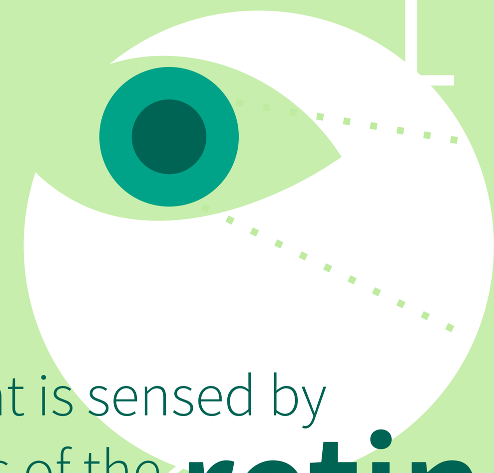

Light is sensed by cells of the **retina**

Neural signals undergo processing by neurons of the retina, and the output takes the form of action potentials in retinal ganglion cells whose axons form the optic nerve.

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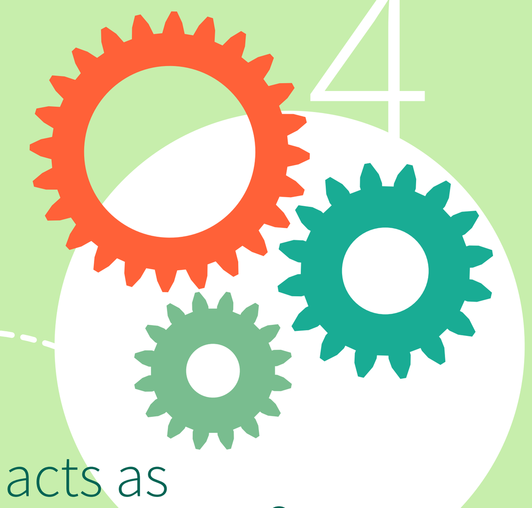
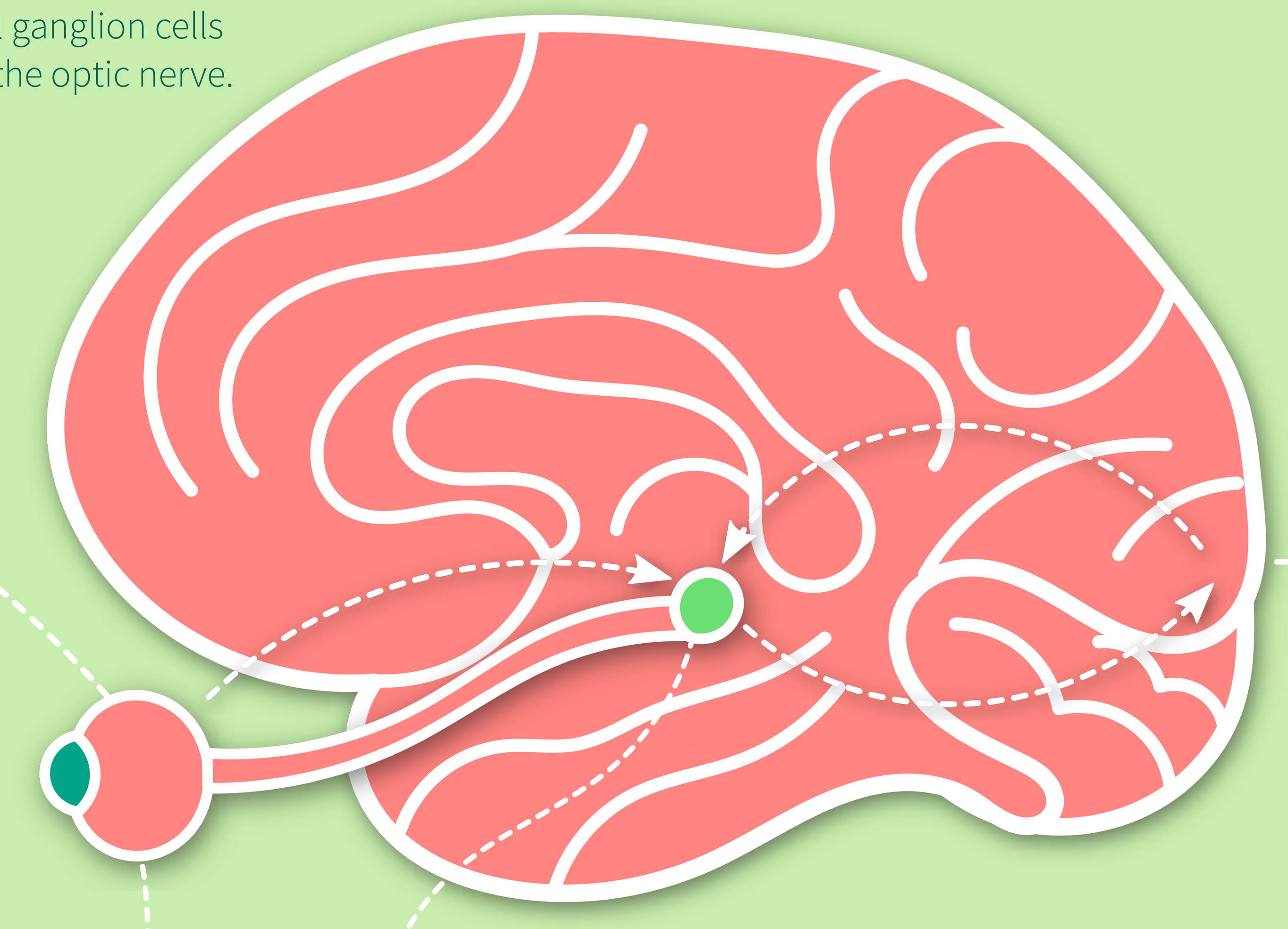
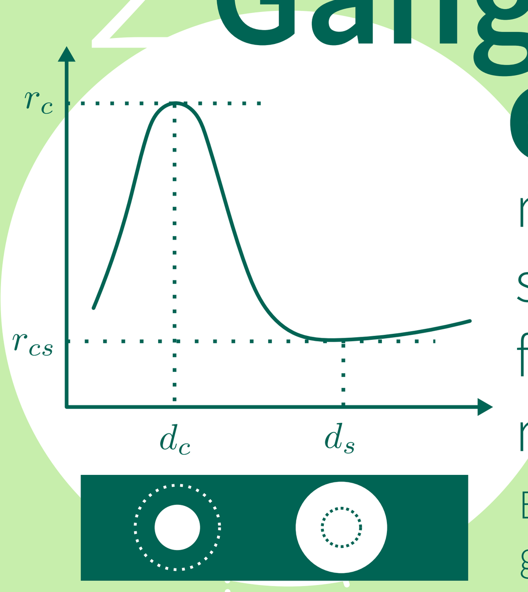


LGN acts as a gateway for signals that reach **visual cortex**

Visual cortex is responsible for processing visual information in the cerebral cortex. Each neuron responds to stimuli in its receptive field, which is a part of the entire visual field. Peak response is achieved for a specific subset of stimuli, for instance vertical bars or more complex processes. This neuronal tuning results from the circuitry of the entire neural network.



2 **Ganglion cells**



respond to spot-shaped features in the receptive field

Each cell responds to light spots in a given position and of a given size. The maximum response occurs when the spot is just the right size. If it is bigger or smaller, the response is weaker.

By use of **optogenetics** the feedback may be activated and inactivated

Cells in visual cortex can be made sensitised to light. By shining light on the LGN, cells that project from visual cortex to LGN can be controlled. They may either be activated or inactivated. This enables experimental study of the feedback from visual cortex to LGN.

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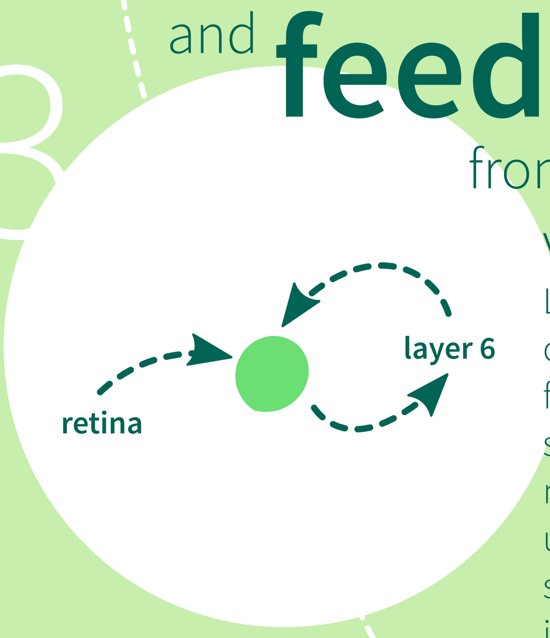
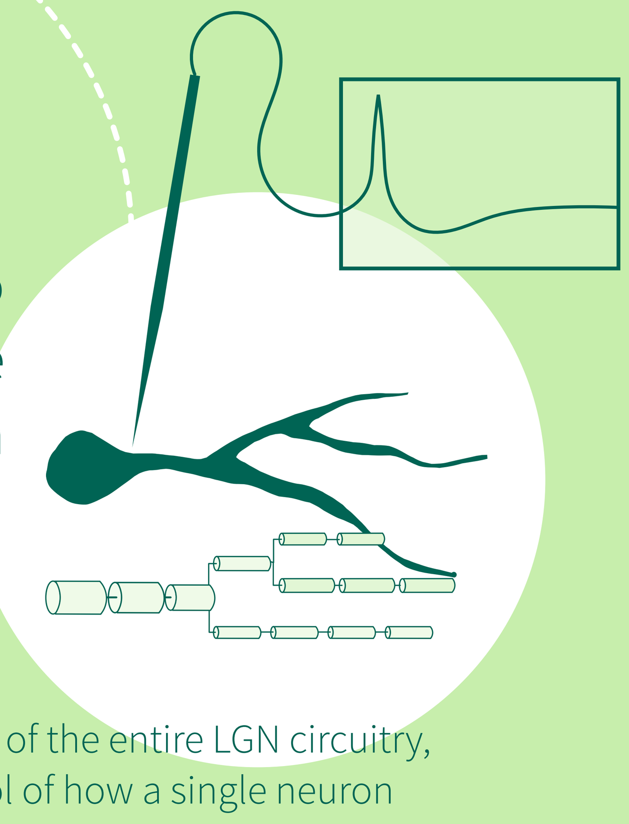
LGN receives feedforward signals from retina and **feedback** from layer six in visual cortex

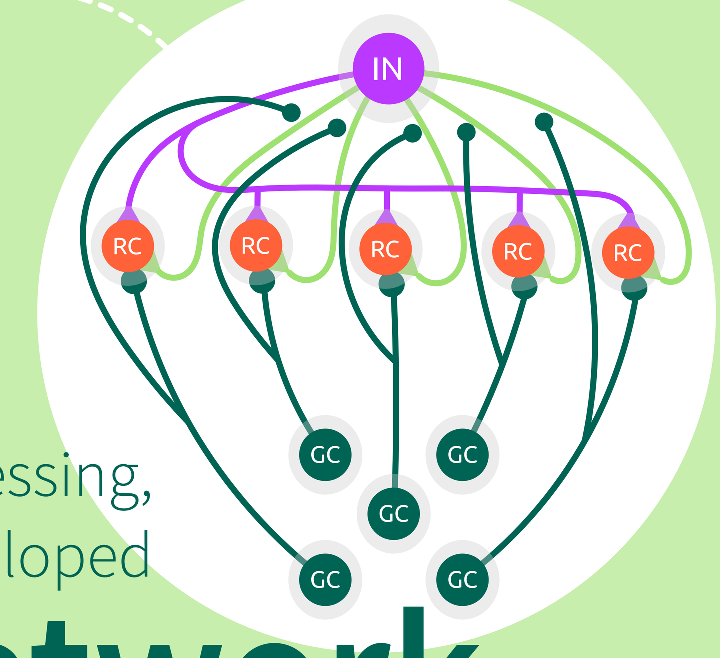


LGN acts as a relay between retina and visual cortex, but visual cortex also gives a massive feedback to LGN. The activity in LGN cells is at first sight similar to those in the retina, and the modulatory role of the cortical feedback is poorly understood. A combination of computational simulations and experiments will be necessary to increase our understanding.



We need to understand the behavior of a **single neuron**

To understand the behavior of the entire LGN circuitry, we also need to have control of how a single neuron behaves in its environment. Experimentally we study the behavior of neurons by inserting microelectrodes into the area of interest. These pick up signals from multiple neurons. To filter out the signals of a single neuron, we use spike sorting methods. These may in turn be compared to signals obtained in simulated neurons. The multicompartmental model is commonly used in simulation. The virtual neuron is divided into compartments and each compartment is simulated as a small electric circuit.



To simulate the LGN processing, we use a newly developed **network model**

Creating a network model for the entire LGN circuit requires a good understanding of the behavior of each type of neuron. Until recently, adequate models of the interneurons have been lacking. However, with the comprehensive multicompartmental model developed by Halnes et. al. (2011), we have obtained the missing piece of the puzzle. We will use this to investigate the entire LGN circuitry.

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