General Introduction

Drosophila melanogaster is a little fly that lives around and on fruits. It is also one of the most valuable organisms in biological research, particularly in genetics and developmental biology. Since the discovery of a family of putative olfactory receptors (Clyne *et al*., 1999;Vosshall *et al*., 1999), the role of *Drosophila* as a model organism for olfactory research has been established.

Olfaction

The olfactory sense is our oldest sense. It gives animals information about food sources, toxins, dangerous circumstances and about mating partners. Odors elicit immediate reactions like flight or courtship behavior, as well as emotions and memories. The olfactory system has the task of recognizing and differentiating thousands of odors surrounding us and to extract important information from background.

The olfactory receptor neurons (ORNs) are located in the olfactory epithelia in the nose of mammals or on the antenna and maxillary palp of insects. Every ORN expresses one or few of a big variety of olfactory receptor genes. Olfactory receptors are G-protein coupled receptors, presented in the membrane of ORNs. Odor molecules are thought to bind to one or few receptors according to their chemical characteristics (e.g. carbon chain length, functional groups), activate a transduction cascade and cause the ORN to spike. Therefore every odorant activates a subset of ORN classes, overlapping with the subset another odorant might activate. ORNs do not only code the identity of odorants but also concentration and time course of the stimulus via spike frequency. ORNs project to the primary olfactory centre in the brain, the olfactory bulb in vertebrates (Mombaerts *et al*., 1996) and the antennal lobes in insects (Vosshall *et al*., 2000). Both, the olfactory bulb (OL) and the antennal lobe (AL), consist of structurally and functionally distinct subunits, the glomeruli.

Each glomerulus receives input from only one ORN class expressing one olfactory receptor. Therefore the response to each odor is reflected in a specific pattern of activated glomeruli in the OL and AL (Joerges *et al*., 1997;Galizia *et al*., 1999) respectively. This combinatorial code is further processed in higher brain centres.

Drosophila melanogaster as model for olfaction research

The fruit fly *Drosophila melanogaster* is very popular as model system. Advantages are easy and fast rearing, the completely sequenced genome (Adams *et al*., 2000), as well as many valuable genetic tools (Brand and Perrimon, 1993;O'Kane and Gehring, 1987;Yeh *et al*., 1995;Golic and Lindquist, 1989), and the smallness of nervous and olfactory system.

The olfactory system of *Drosophila melanogaster* is not homologue to the one of vertebrates but of similar structure. *Drosophila* has around 1300 ORNs and 60 ORs. From one to four ORNs are housed together in hair like structures, the sensilla, distributed on the two olfactory organs, antenna and maxillary palp.

There are three different morphological types of ORNs (basiconic, coeloconic und trichoid sensilla; Anders, 1955; Venkatesh and Singh, 1984, Stocker, 1994, Shanbag, 1999). Basiconic and coeloconic sensilla were further classified according to their odor response spectra (de Bruyne *et al*., 1999;de Bruyne *et al*., 2001;Yao *et al*., 2005).

Recently most of the olfactory receptor genes have been assigned to the sensilla and glomeruli they are expressed in (Couto *et al*., 2005;Fishilevich and Vosshall, 2005).

The thesis is divided into two parts. In the first part the role of the biogenic amine in modulation of olfactory sensilla properties is described. The second part focuses on a special ORN that expresses a gustatory receptor and is involved in CO2 perception.

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