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DISSERTATION SUMMARIES

Distribution of two molecules: KCC2, which plays a role in the postsynaptic responses evoked through $GABA_A$ receptors, and δ-subunit-containing $GABA_A$ receptors, which appoint neruogliaform cells in the neuronal network that can uniquely create the long-lasting postsynaptic $GABA_A$– and $GABA_B$ receptor mediated inhibition on target neurons

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The neuron-specific potassium-chloride cotransporter 2 (KCC2) plays a crucial role in adjusting intracellular Cl^- concentrations. The lack of KCC2 in the plasma membrane of the axon initial segment (AIS) of pyramidal cells contributes to variable reversal potentials for perisomatic γ-aminobutyric acid $GABA_A$ receptor-mediated postsynaptic potentials, but the distribution of KCC2 in pyramidal dendrites remains to be established. We applied high-resolution pre-embedding immunolocalization to quantify KCC2 concentrations along dendritic, somatic and axonal regions of rat hippocampal principal cells. Confirming our results on neocortical pyramidal cells, membranes of AIS of CA1 pyramidal cells and dentate granule cells contained 6.4 ± 11.9% and 6.6 ± 14.1% of somatic KCC2 concentrations, respectively. Concentrations of KCC2 in basal dendritic shafts of stratum (str.) oriens were similar to somatic levels (109.2 ± 48.8%). Along apical dendritic shafts of CA1 pyramidal cells, the concentration of KCC2 showed a complex profile: normalized to somatic levels, the density of KCC2 was 124.5 ± 15.7%, 79 ± 12.4% and 98.2 ± 33.5% in the proximal and distal part of str. radiatum and in str. lacunosum moleculare, respectively. Dendritic spines of CA1 receiving excitatory inputs contained 39.9 ± 8.5% of KCC2 concentration measured in shafts of the same dendritic segments targeted by GABAergic inputs. Dendrites of dentate granule cells, the other glutamatergic cell type in hippocampus, showed higher KCC2 concentration compared with the soma (148.9 ± 54%), but no concentration gradient was detected between proximal and distal dendrites. In conclusion, the density of KCC2 in hippocampal principal cells increases along the axo-somato-dendritic axis with cell type-specific distribution profiles within the dendritic tree.

For the localization of delta subunit of $GABA_A$ receptors ($GABA_{AD}$) we used immunofluorescent method on the neocortex. In addition to a weaker neuropil labeling in supragranular layers presumably due to dendrites of pyramidal cells, a subset of interneurons was strongly positive for the $GABA_{AD}$ The identity of strongly $GABA_{AD}$immunopositive interneurons was initially tested by multiple immunoreactions showing that α-actinin2, known to be expressed by electrophysiologically identified neocortical neurogliaform cells, were present in 65±12 % of $GABA_{AD}$receptor containing cells. However, no overlap was found with interneuron markers such as parvalbumin, somatostatin, calbindin, calretinin and vasoactive intestinal polypeptide. In addition, immunocytochemical labeling patterns in the hippocampus were in line with earlier electrophysiological data showing relatively large tonic inhibition in hippocampal granule cells and molecular layer interneurons in the dentate gyrus and weaker currents in pyramidal cells of the hippocampus. In the CA1 and CA3 regions, a subset of interneurons at the border of stratum radiatum and lacunosum moleculare and another population of interneurons close to stratum pyramidale show strong immunolabeling for $GABA_{AD}$receptors. These interneurons presumably correspond to hippocampal neurogliafrom cells and ivy cells, respectively.

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The molecular and metabolic connections of Hox1 hydrogenase in *Thiocapsa roseopersicina*

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Hydrogen is considered as the most promising fuel of the future, since it can be produced and oxidized without emission of green house gases. Biological systems offer easily reproducible biocatalysts for production of hydrogen. Several microorganisms, including both phototrophs and non-photosynthetic heterotrophs are able to metabolize molecular hydrogen by means of their hydrogenase or nitrogenase enzymes.

Our model organism, *Thiocapsa roseopersicina* is a Gram-negative, anaerob purple sulphur photosynthetic bacterium capable to produce molecular hydrogen as a byproduct during photochemolitoautotrophic growth. The strain can grow on inorganic substrates and utilize small organic molecules such as volatile acids and glucose. It contains four NiFe hydrogenases: two of them are soluble (Hox1 and Hox2) while the other two enzymes are attached to the membrane. The strain has complex sulphur metabolism it is able to fix molecular nitrogen and