Glutamate

Glutamic acid (abbreviated as Glu or E) is one of the 20-23 proteinogenic amino acids, and its codons are GAA and GAG. It is a non-essential aminoacid. The carboxylate anions and salts of glutamic acid are known as glutamates. In neuroscience, glutamate is an important neurotransmitter that plays the principal role in neural activation.

Synaptically released glutamate is largely cleared by glutamate transporters localized on perisynaptic astrocyte processes. Therefore, the substantial variability of astrocyte coverage of individual hippocampal synapses implies that the efficacy of local glutamate uptake and thus the spatial fidelity of synaptic transmission is synapse dependent. By visualization of sub-diffraction-limit perisynaptic astrocytic processes and adjacent postsynaptic spines, Herde et al. showed that, relative to their size, small spines display a stronger coverage by astroglial transporters than bigger neighboring spines. Similarly, glutamate transients evoked by synaptic stimulation are more sensitive to pharmacological inhibition of glutamate uptake at smaller spines, whose high-affinity N-methyl-D-aspartate receptors (NMDARs) are better shielded from remotely released glutamate. At small spines, glutamate-induced and NMDAR-dependent Ca2+ entry is also more strongly increased by uptake inhibition. These findings indicate that spine size inversely correlates with the efficacy of local glutamate uptake and thereby likely determines the probability of synaptic crosstalk [1)].

Sun et al., show that oligodendrocyte progenitor cells perform linear integration of glutamatergic synaptic inputs and respond with increasing dendritic calcium elevations. Synaptic activity induces rapid Ca2+ signals mediated by low-voltage activated Ca2+ channels under strict inhibitory control of voltage-gated A-type K+ channels. Ca2+ signals can be global and originate throughout the cell. However, voltage-gated channels are also found in thin dendrites which act as compartmentalized processing units and generate local calcium transients. Taken together, the activity-dependent control of Ca2+ signals by A-type channels and the global versus local signaling domains make intracellular Ca2+ in NG2 cells a prime signaling molecule to transform neurotransmitter release into activity-dependent myelination [2)].

Chemical shift imaging (CSI) estimates of Glutamate concentrations were compared with known concentrations of Glu in aqueous phantom solutions. Forty-one patients with known or likely supratentorial gliomas underwent preoperative CSI. The spectra obtained were analyzed for Glu concentrations and Glu to creatine (Cr) ratios. These in vivo measurements were correlated against ex vivo Glu content quantified by high performance liquid chromatography (HPLC) measured in 65 resected brain tumor and peritumoral brain specimens. For the phantom solutions the CSI estimates of Glu concentration and the Glu/Cr ratios were highly correlated with known Glu concentration ($r2 = 0.95$, $p = 0.002$, and $r2 = 0.97$, $p < 0.0001$, respectively). There was a modest, but statistically significant, correlation between the ex vivo measured Glu and in vivo spectroscopic Glu concentration ($r2 = 0.22$, $p = 0.04$) and ratios of Glu to Cr ($r2 = 0.30$, $p = 0.002$). Quantitative measurement of Glu content is feasible in patients with supratentorial gliomas using CSI. The in vitro and in vivo results suggest that this has the potential to be a reliable quantitative imaging assay for brain tumor patients. This may have wide clinical research applications in a number of neurological disorders

where Glu excitotoxicity and metabolic dysfunction are known to play a role in pathogenesis, including tumor associated epilepsy, epilepsy, stroke and neurotrauma. [3].

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3)
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