Calcium and protons affect the interaction of neurotransmitters and anesthetics with anionic lipid membranes

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PII: S0005-2736(16)30225-5
DOI: doi: 10.1016/j.bbamem.2016.06.017
Reference: BBAMEM 82251

To appear in: *BBA - Biomembranes*

Received date: 10 February 2016
Revised date: 16 June 2016
Accepted date: 22 June 2016

Please cite this article as: Rosendo Pérez-Isidoro, J.C. Ruiz-Suárez, Calcium and protons affect the interaction of neurotransmitters and anesthetics with anionic lipid membranes, *BBA - Biomembranes* (2016), doi: 10.1016/j.bbamem.2016.06.017

Calcium and protons affect the interaction of neurotransmitters and anesthetics with anionic lipid membranes

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Abstract

We study how zwitterionic and anionic biomembrane models interact with neurotransmitters (NTs) and anesthetics (ATs) in the presence of Ca^{2+} and different pH conditions. As NTs we used acetylcholine (ACh), γ-aminobutyric acid (GABA), and L-glutamic acid (LGlu). As ATs, tetracaine (TC), and pentobarbital (PB) were employed. By using differential scanning calorimetry (DSC), we analysed the changes such molecules produce in the thermal properties of the membranes. We found that calcium and pH play important roles in the interactions of NTs and ATs with the anionic lipid membranes. Changes in pH promote deprotonation of the phosphate groups in anionic phospholipids inducing electrostatic interactions between them and NTs; but if Ca^{2+} ions are in the system, these act as bridges. Such interactions impact the physical properties of the membranes in a similar manner that anesthetics do. Beyond the usual biochemical approach, we claim that these effects should be taken into account to understand the excitatory-inhibitory orchestrated balance in the nervous system.

Keywords: `Chemical synapses, Anesthesia, Calorimetry, Lipid membrane, Calcium, Protons.`

Abbreviations

Cp, specific heat capacity at constant pressure; DPPC, 1,2-dipalmitoyl-*sn*-glycero-3-phosphocholine; DPPA, 1,2-dipalmitoyl-*sn*-glycero-3-phosphate (sodium salt); DPPG, 1,2-dihexadecanoyl-*sn*-glycero-3-phospho-(1'-*rac*-glycerol) (sodium salt); DMPS, 1,2-ditetradecanoyl-*sn*-glycero-3-phospho-L-serine (sodium salt); SM, N-octadecanoyl-D-*erythro*-sphingosylphosphorylcholine; ACh, acetylcholine;

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