

Probing the Anesthetic Effects of Xenon by Studying the Biophysical Changes of DOPC Liposomes

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Structural and dynamic changes in cell membrane properties induced by volatile anesthetic molecules, such as xenon, may affect the function of membrane-associated proteins, providing a hypothesis for the mechanism of general anesthetic action. In this study, molecular dynamics simulations were performed on multiple systems consisting of dioleoylphosphatidylcholine (DOPC) bilayers exposed to xenon gas at 310 K and pressures ranging from 1 to 200 bar. Simulations were done for fully hydrated systems containing either a single lipid bilayer or two bilayers separated by an aqueous phase. The permeation of xenon atoms into the lipid bilayer and the effects on bilayer properties were characterized. The xenon atoms were found to preferentially localize in the hydrophobic core of the bilayer, resulting in an increase in the area per lipid, bilayer thickness, and ordering of the lipid acyl chains in the presence of xenon. Increased pressures produced no significant change in bilayer properties at 50-100 bar but decreased bilayer thicknesses were observed at higher pressures. To complement the simulations, differential scanning calorimetry (DSC) measurements were also made to assess the impact of xenon on the DOPC liposomes main phase transition temperature, with xenon producing a concentration-dependent decrease in the transition temperature. Both the simulations and DSC measurements indicate the effects of xenon permeation on the membrane properties to be reversible.