A dialysate of blood plasma, synovial fluid is a critical component for the lubrication of articular joints in mammals. The ability of synovial joints to resist anisotropic compression while maintaining low friction suggests areas for medical advances and artificial lubrication. The multilamellar structure of surface active phospholipids present in synovial fluid may represent a critical component of these properties. Computer simulation using coarse grain molecular dynamics provides opportunity to analyze and design future experiments. In this investigation, we are creating a fluid ball bearing model of the synovial fluid structure in Large Atomic/Molecular Massively Parallel Simulator (LAMMPS) to study these features. We will use the model to simulate anisotropic compression and other stress states for phospholipid bilayers and vesicles in order to analyze the features and breakdown of the supramolecular structure at different hydration levels. These steps will help to characterize the rheology of this unique structure and its contributions to the general properties of synovial fluid.