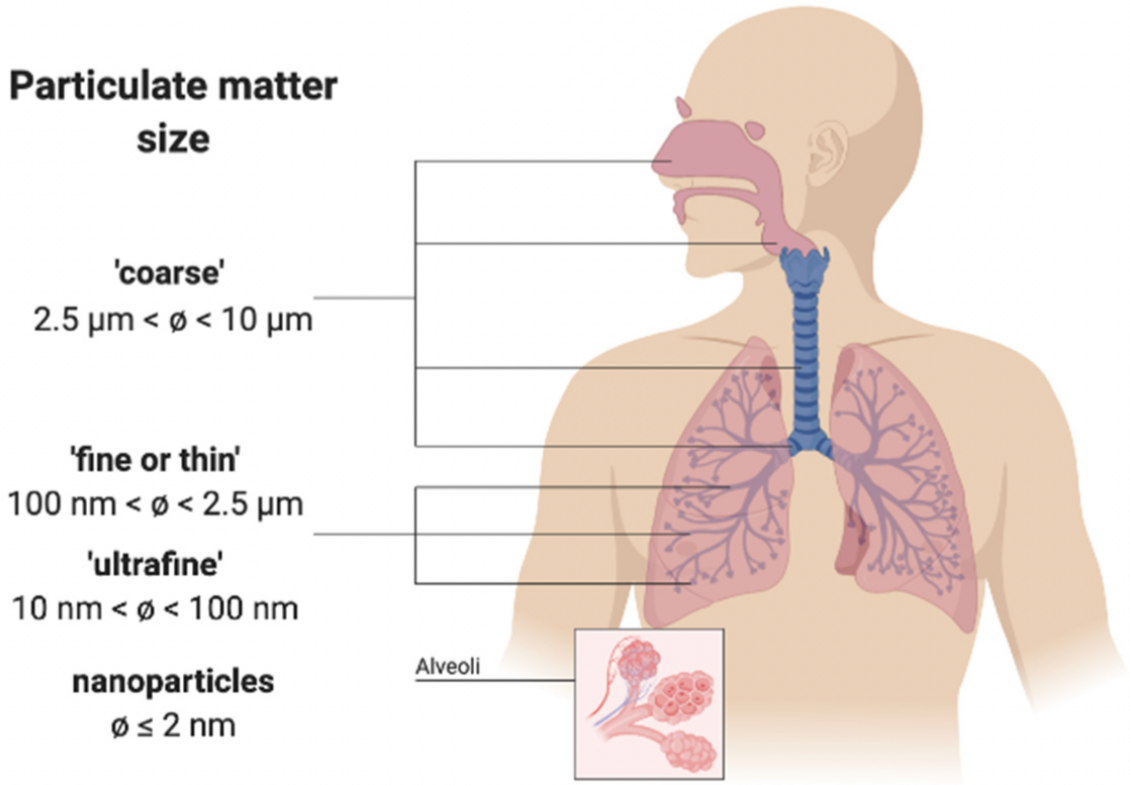
Silica and Nano-materials Induce Red Blood Cell and Liposome Membrane Disruption That is Regulated By Cholesterol Content

Matthew J. Sydor, Donald S. Anderson, Harmen B.B. Steele, J.B. Alexander Ross, and Andrij Holian

Impacts of Silica and Nano-materials on Human Health

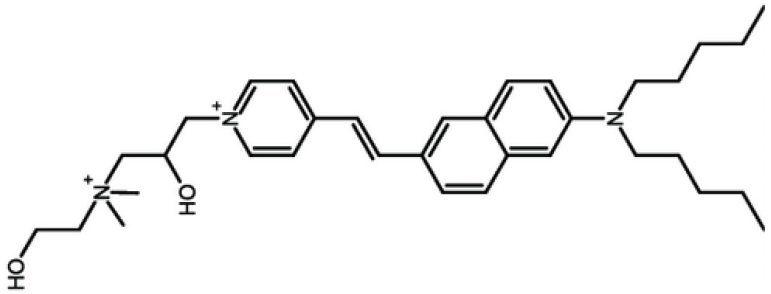
- Silica dusts in the micron size range are often produced by quarrying, sandblasting, and stone cutting
- Years of silica exposure can lead to inflammatory lung disease called chronic silicosis
- NIEHS: Nano-materials are engineered to have at least one dimension less than 100-nm
- Inhalation of particulates can lead to inflammation and lung disease

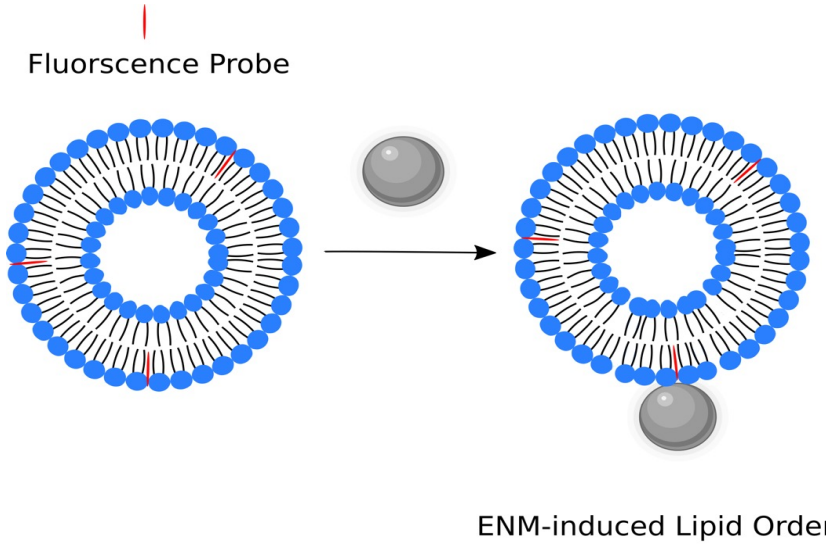


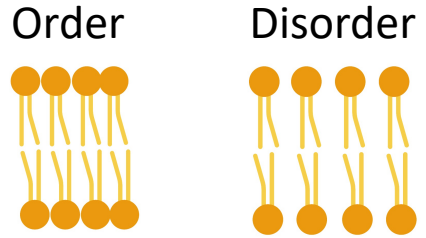
Particles and Lipid Membranes

- These particles may come into contact with external and internal membranes of lung cells
- This work used a fluorescence probe in human red blood cell (RBC) and 100-nm liposome membranes to model these interactions.
- We hypothesize that interactions between particles and membranes will result in a change to lipid order.

Di-4-ANEPPDHQ

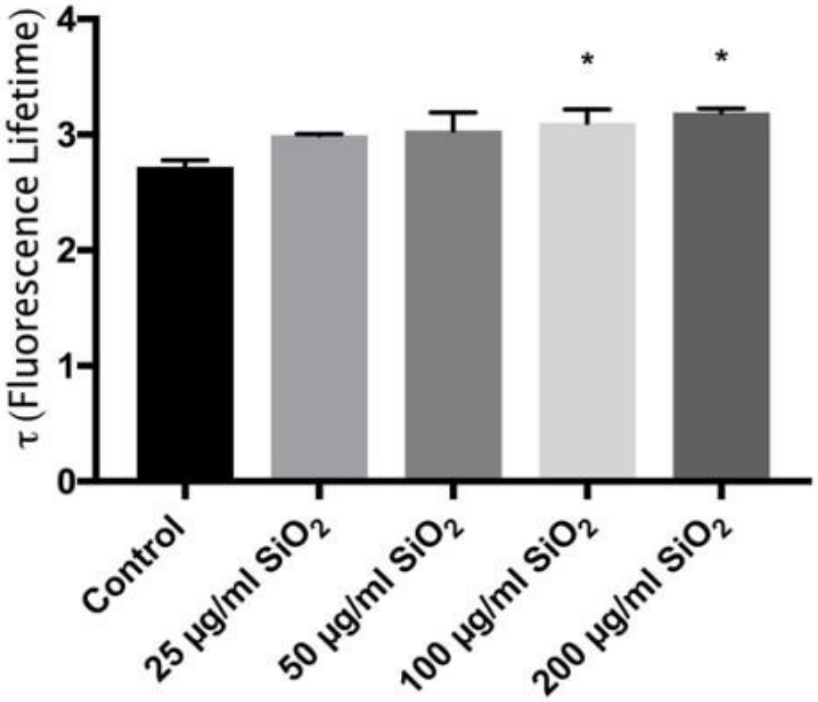






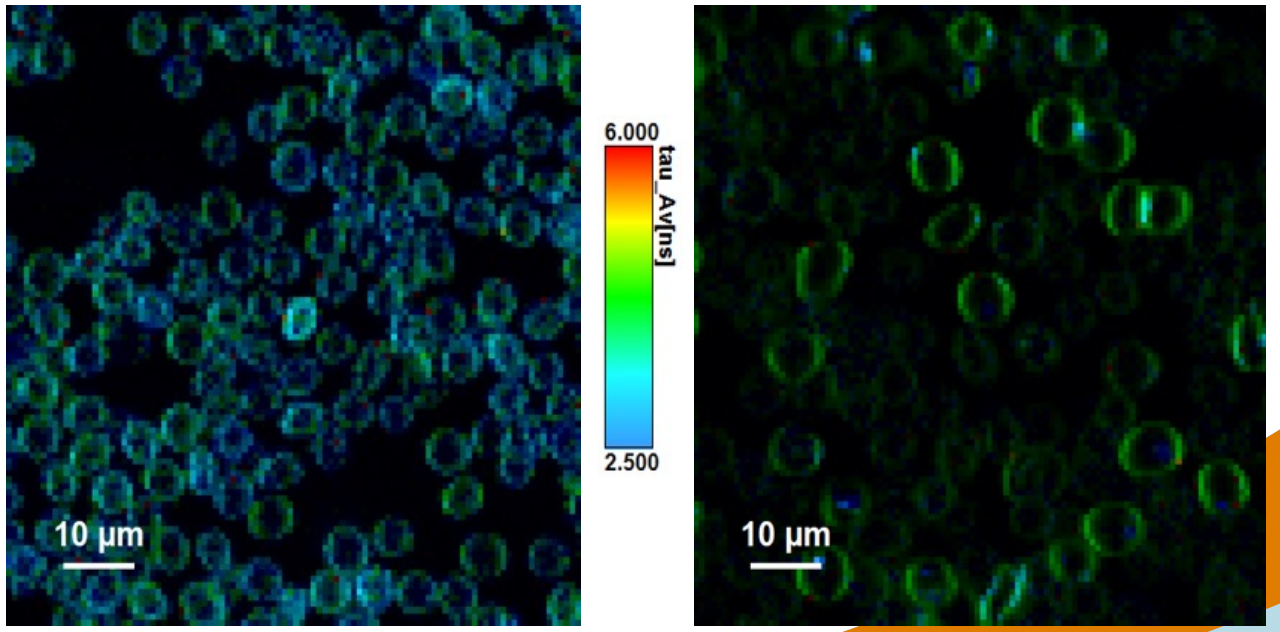
Silica Changes RBC Membranes

- Fluorescence lifetime imaging microscopy (FLIM) was used to analyze RBC membrane order
- Di-4ANEPPDHQ was added to the RBC membranes to detect changes from particles
- An increased fluorescence lifetime indicates an increase in lipid order, while a lowered fluorescence lifetime shows the opposite



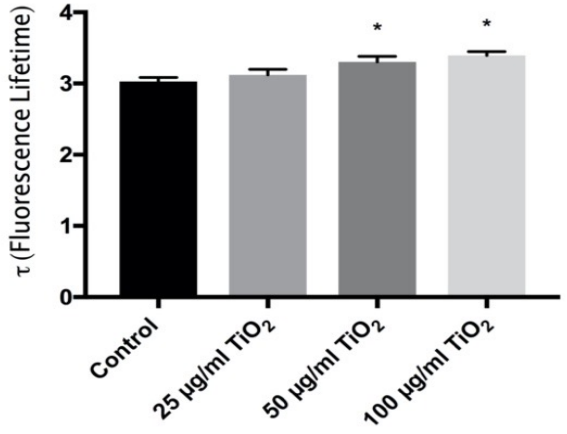
Control

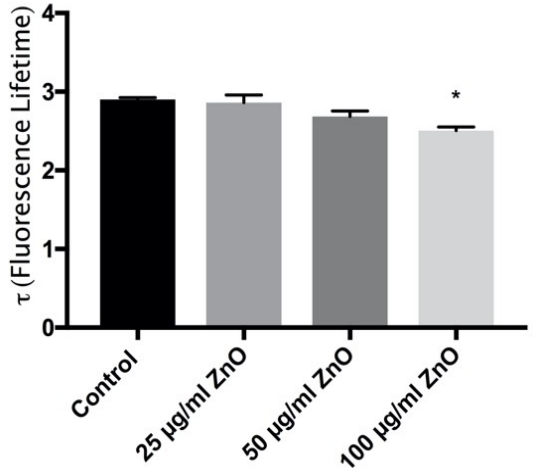
Silica treated



Impacts of Nanomaterials on RBC Membranes

- TiO_2 increased fluorescence lifetime, indicating an increase in lipid order
- ZnO decreased fluorescence lifetime, indicating a decrease in lipid order

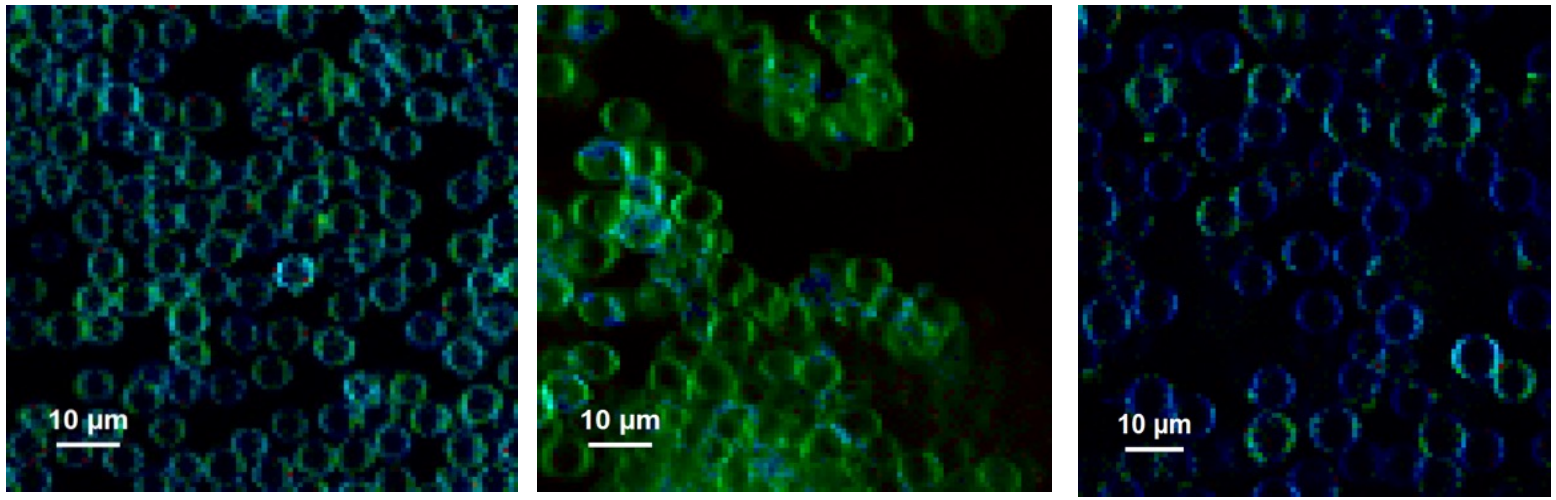




Control

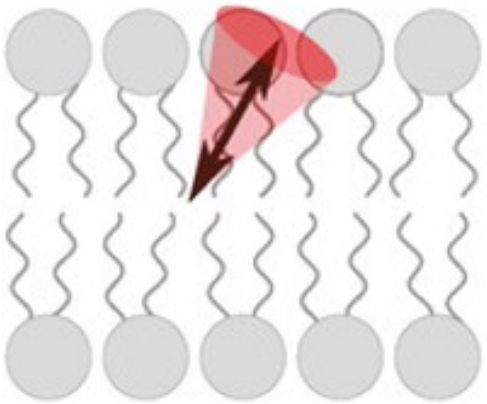
TiO_2 treated

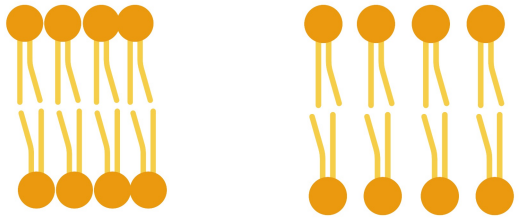
ZnO treated



Time-resolved Anisotropy in Membranes

- **Measures fluorescence depolarization caused by rotation of a fluorophore**

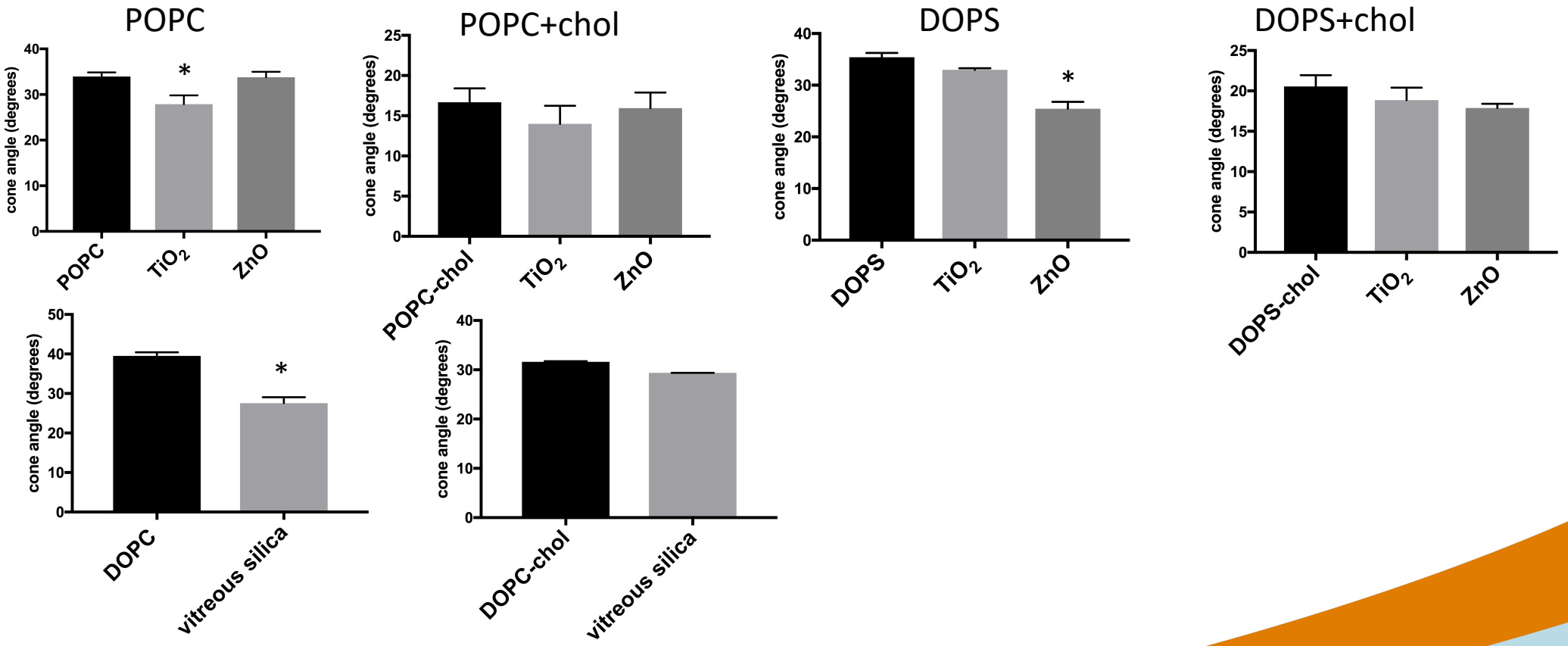




Lakowicz, J. R. *Principles of Fluorescence Spectroscopy*, 3rd ed.; Springer: New York, 2006.

Cholesterol regulates Silica and Nano-material Induced Changes to Liposomes

- **Time-resolved anisotropy measurement of Di-4-ANEPPDHQ in 100-nm liposomes were taken**



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Conclusion

- Incubation of RBC and liposomes with particles results in changes to membrane order
- Membrane composition and the type of particle dictate the change to order
- Cholesterol content in liposomes attenuated the changes induced by silica and nano-materials.
- Mechanisms of particle-induced membrane permeability may help develop therapeutics and design safer materials.

Acknowledgments

- National Institutes of Health : R01ES023209, 1F32ES027324, P20GM103546, and P30GM103338
- National Science Foundation: CHE-1531520
- M.J. Murdock Charitable Trust
- Dr. Francesco Turci's Lab