# Indian Institute of Science
## Centre for BioSystems Science and Engineering
## BSSE Seminar

**11 January 2021, 5:00 p.m., Virtual**

# Lipid nanoparticles for RNA delivery: SARS-CoV2 vaccines, chemistry, and beyond

**Prof. Kathryn A. Whitehead,**
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**About the speaker:**

Kathryn A. Whitehead is an Associate Professor and Dean's Career Fellow in the Departments of Chemical Engineering and Biomedical Engineering (courtesy) at Carnegie Mellon University. Her lab develops RNA and protein drug delivery systems and has a long-term goal of predicting the behavior of delivery materials in humans. She received an H.B.Ch.E Degree with Distinction from the University of Delaware (2002) and a Ph.D. in chemical engineering from the University of California, Santa Barbara (2007) before serving as an NIH Ruth L. Kirschstein Postdoctoral Fellow at the Massachusetts Institute of Technology (2008 – 2012). Prof. Whitehead is the recipient of numerous awards, including the NIH Director's New Innovator Award, the DARPA Young Faculty Award, the DARPA Director's Fellowship, the ASEE Curtis W. McGraw Research Award, and the Kun Li Award for Excellence in Education. Prof. Whitehead was named as a Pioneer on the MIT Technology Review's Innovators Under 35 list in 2014 as well as one of the Brilliant Ten by Popular Science in 2015. Her publications have been cited over 6,000 times, and several of her patents have been licensed and sublicensed for reagent and therapeutic use.

**Abstract:**

Messenger RNA (mRNA) therapeutics have been thrust into the limelight, thanks to the early, positive clinical trial news on a SARS-CoV2 vaccine from Pfizer/BioNTech and Moderna. These vaccines were made possible by a herculean effort to overcome the most significant barriers that have hindered translational efforts. Arguably, the largest challenge has been that RNA molecules do not readily enter their cellular targets within the body. This is because they are large (104 – 106 g/mol) and negatively charged; they do not have favorable biodistribution properties nor an ability to cross the cellular membrane of target cells. In response to these issues, industrial and academic laboratories, including my own, have created lipid nanoparticles that spontaneously package RNA and deliver the RNA to key cellular targets in vivo. Here, I will describe biodegradable, ionizable lipid-like materials called 'lipidoids' that my lab has used to create RNA-loaded lipid nanoparticles that induce protein expression in mice. Lipidoids efficiently manipulate gene expression in a variety of biological systems, including the liver, the lungs, and immune cells. This talk will focus, specifically, on the cell-

free prediction of lipidoid efficacy in delivering mRNA to mice. I will also describe a new formulation strategy for the synergistic co-delivery of mRNA and siRNA. Together, these data advance our understanding of lipid nanoparticle chemistry and are expected to contribute to the successful formulation of future generations of mRNA therapies.