Title: From biomass to bioproducts: Designing sustainable materials with cellulose & protein

Short Bio: Dr. Kevin De France is an Assistant Professor in the Department of Chemical Engineering, with a Cross Appointment to the Department of Chemistry (one of us!). His group, the Natural Nanocomposites Lab, focuses on the development of sustainable materials from natural sources such as cellulose and protein. The work in the De France Lab is highly interdisciplinary, spanning materials chemistry, engineering, and biotechnology, with the end goal of replacing petroleum-based products with high-performance renewable materials in the agricultural, packaging, water treatment, energy systems, and biomedical sectors. Kevin is an Early Career Editorial Board Member for *ACS Applied Bio Materials*, and is on the Executive Committee of the *Chemical Institute of Canada Green Division*. He is the recipient of the 2025 Queen's University Frank Knox Award for excellence in teaching, the 2024 Queen's University Undergraduate Research Mentorship Award for dedication to supervision, and was recognized as a member of the 2024 Kingston Young Professionals 40 Under 40 for professional achievements, innovation, and ability to lead and inspire.

Abstract: The development of high-performance sustainable materials as a practical replacement for non-renewable products represents one of the most significant challenges of the 21st century. To this end, the primary research interests of our group surround the rational design and assembly of functional materials from biomass. Prominent examples of this include the extraction and assembly of materials from canola meal (supported by an inter-institutional $3.2M NSERC Sustainable Agriculture Grant, which Dr. De France leads) and microalgae. A typical workflow in the De France Lab encompasses the synthesis and modification of nanomaterial 'building blocks' from cellulose or proteins – two of the most abundant natural polymers on Earth. We then utilize these building blocks (for example: cellulose nanocrystals and protein nanofibers) in the bottom-up fabrication of materials such as hydrogels, aerogels, emulsions, and films. An emphasis is placed on understanding and leveraging structure-function relationships between individual building blocks and fabricated material assemblies in order to improve key performance metrics such as mechanical strength, adhesive potential, and structural ordering. Taken together, the design and engineering of sustainable materials from biomass represents a significant milestone towards a collective greener future.