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Friday, January 29, 2021 | **ZOOM** | 10:00-11:30 AM

Title | Biology-Inspired Polymer Design

Abstract | Working at the interface of chemistry, biology, and engineering, we are designing polymer strategies with the individual in mind. We are investigating models of disease to determine how we can better understand disease progression and how we can stop and reverse that disease instead of merely treating its symptoms. I will share three stories that are promising in cancer, blindness and stroke. In each story, I will highlight both the underlying polymer innovation and the opportunities that lay ahead.

In cancer, we wondered whether we could find a way to grow cancer cells in a biomimetic environment. To do this, we synthesized a hyaluronan-crosslinked hydrogel, in which to grow cells. Now, for the first time, we can investigate drugs for their effects on both cell viability and cell invasion [1]. This is particularly important in highly invasive diseases.

In blindness diseases, such as age-related macular degeneration, the photoreceptors and the retinal pigmented epithelium die. In order to stop and reverse blindness, these cells need to be replaced, yet finding a source of these cells is in itself difficult. We found that conventional strategies of transplanting these cells resulted in significant cell death. We designed an injectable hydrogel in which to transplant the cells and observed significantly greater survival and some functional repair [2].

The holy grail of regenerative medicine is stimulation of the stem cells that are already resident in us. Until the early 1990s, we didn't think that our brains had the capacity to regenerate. We now know that we all have stem cells in our brains. The challenge is to figure out how to stimulate them to promote repair. We designed a composite hydrogel that could be applied directly on the brain in a model of stroke. With the release of two proteins, we demonstrated that these resident stem cells could be stimulated to promote tissue and functional repair [3].

These three stories underline the opportunity of collaborative, multi-disciplinary research at the intersection of chemistry, biology and engineering applied to solving problems in medicine. It is exciting to think what we will discover as this research continues to unfold.

Acknowledgements: We are grateful for funding from the Natural Sciences and Engineering Research Council of Canada, the Canadian Institutes of Health Research, the Canada Research Chairs program, the Canada First Research Excellence Fund via Medicine by Design, and Green Eggs and LAM.

References:

[1] Tam RY; Yockell-Lelievre J; Smith LJ; Julian LM; Choey C; Baker AEG; Hasim MS; Dimitroulakos J; Stanford WL; Shoichet MS. 2018 "Rationally designed 3D hydrogels model invasive lung diseases enabling high-content drug screening" Advanced Materials, 1806214: 1-9.

[2] Mitrousis N; Hacibekiroglu S; Ho MT; Sauvé Y; Nagy A; van der Kooy D; Shoichet MS. 2020 "Hydrogel-mediated co-transplantation of retinal pigmented epithelium and photoreceptors restores vision in an animal model of advanced retinal degeneration" Biomaterials, 257: 120233.

[3] Tuladhar A; Obermeyer JM; Payne SL; Siu RCW; Zand S; Morshead CM; Shoichet MS. 2020 "Injectable hydrogel enables local and sustained co-delivery to the brain: Two clinically approved biomolecules, cyclosporine and erythropoietin, accelerate functional recovery in rat model of stroke" Biomaterials, 235: 119794; doi: 10.1016/j.biomaterials.2020.119794

Bio | Molly Shoichet is an expert in the study of polymers for drug delivery and tissue regeneration. She holds the Tier 1 Canada Research Chair in Tissue Engineering and is Professor of Chemical Engineering & Applied Chemistry and Biomaterials & Biomedical Engineering at the University of Toronto. Professor Shoichet was recruited to the faculty at the University of Toronto in 1995 with a NSERC University Faculty Award, after completing her S.B. from the Massachusetts Institute of Technology (Chemistry, 1987), her Ph.D. from the University of Massachusetts, Amherst (Polymer Science & Engineering, 1992), and three years at CytoTherapeutics Inc.

Professor Shoichet was promoted to Full Professor in 2004, after being named one of Canada's Top 40 under 40 (2002), and receiving CIFAR's Young Explorer's Award (to the top 20 scientists under 40 in Canada, 2002) and NSERC's Steacie Research Fellowship (2003-2005). In 2014, Professor Shoichet was appointed University Professor in recognition of her dedication to the advancement of knowledge and the University's academic mission, and her excellence as a teacher, mentor and researcher. This is the University of Toronto's highest distinction, and is held by less than 2% of the faculty. In 2015, Professor Shoichet was the North American Laureate for the L'Oreal-UNESCO for Women in Science and in 2016, she was named foreign member of the US National Academy of Engineering. In 2017, Professor Shoichet won the Killam Prize in Engineering, the most important engineering prize in Canada. In 2018, Professor Shoichet was appointed Chief Scientist, Ontario and inducted as an Officer of the Order of Canada – one of the highest distinctions for a Canadian.

Professor Shoichet aims to advance the basic science and enabling technologies of tissue engineering and drug delivery. She is a world leader in the areas of polymer synthesis, biomaterials design and drug delivery in the nervous system. Her research program is unique in its breadth, focusing on strategies to promote tissue repair after traumatic spinal cord injury, stroke and blindness and enhance both tumour targeting through innovative strategies and drug screening via 3D cell culture with new hydrogel design strategies.

Professor Shoichet has published over 575 papers, patents and abstracts, has given over 350 lectures worldwide and has trained over 185 scientists in the past 22 years. Her students are pursuing careers in academia, industry and government. She founded three spin-off companies and is actively engaged in translational research with several industry partners and in science outreach. In 2015, Professor Shoichet launched a national social media initiative, Research2Reality, aimed at engaging the public in the importance of research. Professor Shoichet served as an inaugural member on the Science, Technology & Innovation Council, providing strategic guidance to the Prime Minister of Canada (for 6 years), the Ontario Research & Innovation Council (for 2 years) and the Board of the Ontario Centres of Excellence (for 6 years). She is currently Senior Advisor on Science & Engineering Engagement at U of T and serves on the Board of the Ontario Science Centre.

Molly Shoichet is the recipient of 44 prestigious national and international awards. She is the only person ever to be inducted into all three of Canada's National Academies: the Canadian Academy of Sciences of the Royal Society of Canada, the Canadian Academy of Engineering, and the Canadian Academy of Health Sciences. Moreover, she is a Fellow of the American Association for the Advancement of Science and recipient of the Clemson Award from the American Society for Biomaterials, the Senior Scientist Award from the Tissue Engineering and Regenerative Medicine International Society, Americas, and the Killam Research Fellowship from the Canada Council for the Arts, among many others. In 2011, Dr. Shoichet was appointed to the Order of Ontario, Ontario's highest civilian honour. In 2013, her contributions to Canada's innovation agenda and the advancement of knowledge were recognized with the QEII Diamond Jubilee Award.

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