Paving the Way in Biomedical Engineering: An Interview with Dr. Molly Shoichet

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Dr. Molly Shoichet

Dr. Molly Shoichet holds the Tier 1 Canada Research Chair in Tissue Engineering and is a professor of Chemical Engineering & Applied Chemistry, Chemistry, and Biomaterials & Biomedical Engineering at the University of Toronto. Dr. Shoichet first received her Bachelor of Science in Chemistry from the Massachusetts Institute of Technology (MIT) before going on to complete a Ph.D. in Polymer Science and Engineering at the University of Massachusetts Amherst in 1992. As a world-renowned expert in the study of polymers for tissue engineering, drug delivery, and regenerative medicine, Dr. Shoichet's lab leads the way in the development of innovative biomedical technologies. Through the application of engineering, chemistry, and biology, Dr. Shoichet's work endeavors to solve medical problems, such as how to improve recovery from spinal cord and stroke injury. A few of Dr. Shoichet's ongoing research projects include the development of novel biodegradable polymers that allow for targeted delivery of chemotherapeutic agents and minimally invasive hydrogels for cell delivery to the brain, retina, and spinal cord. Dr. Shoichet's significant contributions to scientific research have been recognized by many prestigious distinctions including the Queen Elizabeth II Diamond Jubilee Award (2013), the Order of Ontario (2011), and her role as a Fellow of the Royal Society of Canada (2008-Present).

UTMJ: Can you describe how you came to be interested in regenerative medicine and your journey from student to scientist?

MS: This is a long answer, but briefly….when I was an undergraduate student at MIT, I became fascinated with polymers. I decided to pursue a PhD in Polymer Science and Engineering at the University of Massachusetts Amherst instead of going to medical school (first I deferred med school and then I finally decided not to go). During my PhD, I was always interested in medical applications of polymers and thus, when I had the opportunity to join CytoTherapeutics (an encapsulated cell therapy company), I did. Et voila – I had joined the field of regenerative medicine before it was called regenerative medicine. I spent three years in the biotech industry in the USA (United States of America) and when I started to look for opportunities in Canada, I was most excited by those at the University of Toronto (UofT), largely due to my professional interactions with Michael Sefton (Chemical Engineering, UofT). I joined UofT in 1995 with an NSERC University Faculty Award and have been thrilled to build my career here.

UTMJ: Can you tell us a bit about what your lab does? What is it about regenerative medicine and biomaterials that most interests you?

MS: Our inventions are all in biomaterials. We invent new materials to overcome problems. These materials are able to achieve success where others have failed. We use a significant amount of biomaterials chemistry to achieve success. Our strategies are enabling. We look to biomaterials to achieve targeted delivery, grow cells in 3D, stimulate endogenous stem cells, and deliver stem cells.

UTMJ: What role, if any, do particular disease models play in your research? Do you endeavor to design biomaterials/technologies that are specific to given disease models or is your goal to discover more broadly applicable solutions to basic physiological problems?

MS: We use disease models in all aspects of our research. We look at a biological or medical problem and then work backwards to create a series of design criteria that we think are required to be successful. Inevitably, we are designing solutions to ill-defined problems. Our results enable us to better define the problem and thus propose a better solution. It is an iterative process.

UTMJ: What are some of the major considerations when designing biomaterials and therapeutic technologies that will ultimately move from bench to bedside? Are there any common barriers to successfully achieving clinically useful, safe, and effective biotechnologies?

MS: Simplicity is key. There are many stars that need to align for a technology to make it into the market. The technology has to work, it has to be scalable, [and] it has to result in a real clinical benefit – that is, there must be a market need. A big market is better than a small market, if you're going after venture capital. Safety is key but insufficient. It has to be safe and efficacious. Ultimately, you need a strong business team and strategy to transition from the invention (a patent or family of patents is usually required) to the innovation and the market.

UTMJ: If you had to predict the next big thing in the world of regenerative medicine, intelligent drug delivery, and/or biomaterials, what would it be?

MS: There are so many opportunities. It's hard to pick one. But cell delivery to the retina to overcome blindness has tremendous potential. Our biomaterials strategy is a key component of success. Having biomaterials that are easily injectable while promoting cell survival is key. Another hot area is 3D cell culture using biomimetic biomaterials to achieve tissue-like conditions in vitro.

UTMJ: What is the importance of interdisciplinary teams in the research you do? What is the role of clinicians, if any (i.e. dialogue, research, providing basic scientists with access to data from patient populations, tissue samples…)?

MS: Everything we do depends on the strength of our collaborators and interdisciplinary research teams. We work collaboratively with basic biologists, neuroscientists, stem cell biologists, surgeons, and clinicians. Our medical colleagues provide us with key insights into the problems that require solutions, design of experiments, interpretation of results, and access to human-derived tissue on occasion.

UTMJ: What are the three most important characteristics of a successful/ideal regenerative medicine technology (or any biomaterial technology)?

MS: To be successful it has to work. For cell transplantation, the biomaterial has to support cell survival and cell integration with the host tissue.

UTMJ: Do you have any mentors or idols in the world of biomedical engineering [BME], healthcare technology, or science as a whole that you look to for inspiration?

MS: In BME, Robert Langer (MIT) is a superstar. He is one of the founding fathers of tissue engineering and drug delivery. He's innovative, creative, generous, and supportive. Closer to home, Michael Sefton (UofT) is incredibly insightful and smart, creative, and supportive. He is one of [the] founding fathers of encapsulated cell therapy and blood-contacting materials.

UTMJ: What is the most important thing you have learned over the course of your career in biomedical research?

MS: Take risks. Don't be reckless, but also don't fear failure. Stay in the game. Be tenacious.

UTMJ: Dr. Shoichet, thank you for your time and for sharing your perspective with us. We cannot wait to see what you do next!