International Internship at University of Toronto

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Country: Canada

Institute: Department of Materials Science and Engineering, University of Toronto Supervisor: Prof. Naomi Matsuura

1. Research in UofT

At the Matsuura Lab, I have been conducting research on the development of microparticle materials for embolization therapy, targeting knee osteoarthritis and primary liver cancer. As part of this work, I have investigated hyaluronic acid (HA) microparticles with enhanced mechanical properties, achieved through sodium citrate treatment. Using emulsification crosslinking, I have been able to synthesize HA microparticles ranging from 50 to 300 μ m in diameter. These microparticles degrade within an appropriate timeframe in an enzyme environment simulating plasma and effectively occlude microchannels. By targeting angiogenesis and perivascular nerve growth, they offer a safe and promising therapeutic option.

My research is part of a collaborative project exploring the incorporation of protein-based pharmaceuticals into HA microparticles used as temporary embolic agents. My previous studies have shown that polysaccharide-based nanogels can efficiently and stably complex with proteins. Building on this, I successfully introduced nanogels into HA microparticles by freeze-drying them

with a high-concentration sucrose solution as a protective agent, followed by the addition of a highconcentration nanogel solution (Fig.1). These findings suggest that HA microparticles can serve as stable carriers for protein-based pharmaceuticals. In future studies, I plan to refine this approach by incorporating nanogel-complexed HA microparticles and evaluating their potential with model proteins such as PD-1 inhibitors and STING agonists for cancer immunotherapy.



Fig.1 Bright field and fluorescence imaging of nanogel-loaded hyaluronic acid hydrogel microsphere. The length of the scale bar is 200 μm

This research contributes to my doctoral program and has provided me with valuable insights for both scientific advancement and my future career development.

2. Daily life in Toronto

Toronto is the capital city of Ontario and one of the most popular cities in Canada. During my visit, it was winter in Toronto, and the weather was extremely cold, around -20°C. This year, in particular, the snowfall has been heavy, reaching about 30 cm. Due to the influence of Lake Ontario, the temperature fluctuates significantly each day. I stayed in a sublet apartment and commuted to campus by streetcar and subway. On snowy days, the journey to school can be quite challenging. Toronto is a highly diverse city, and near the University of Toronto campus, there are many restaurants offering cuisine from different countries. Having easy access to Asian food has been especially convenient for me.

Beyond my studies, I have also explored the city. I visited Niagara Falls, one of the world's largest and most famous waterfalls. It's very impressive. Other highlights was watching the musical *Come From Away*, which is based on the true story of the Canadian town of Gander, Newfoundland. It depicts how the community welcomed nearly 7,000 stranded airline passengers when U.S. airspace was closed on September 11, 2001.

I also had the opportunity to go skiing at Blue Mountain, located in northern Ontario, thanks to one of my lab members who kindly drove me there. On the way, we passed by a ski race, which made me realize how much Canadians love sports, even in winter. Perhaps due to the harsh winter conditions, Canada has developed a strong culture of winter sports, such as hockey and skiing.



Niagara Falls and the ski resort in Blue Mountain

3. Acknowledgement

I would like to express my sincere appreciation to Professor Naomi Matsuura and the members of Matsuura's lab for their invaluable support. I also appreciate the financial support provided by the Discretionary Expense of DoGS SPRING Program.