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Ph.D. DISSERTATION DEFENSE

Candidate:	Huan Han
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School/Department:	Charles V. Schaefer, Jr. School of Engineering and Science / Department of Biomedical Engineering
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Title:	In Vivo Optical Imaging of Oviduct Transport Function and Ovarian Cancer Outgrowth in The Mouse Model
Chairperson:	Dr. Shang Wang, Department of Biomedical Engineering
Committee Members:	Dr. Hongjun Wang, Department of Biomedical Engineering Dr. Yu Gan, Department of Biomedical Engineering Dr. Marcin Iwanicki, Department of Chemistry and Chemical Biology

ABSTRACT

This dissertation addresses the challenges of studying the cause of tubal ectopic pregnancy and the spread of ovarian cancer. These challenges are reflected by the difficulties in analyzing how the oviduct (fallopian tube) transports preimplantation embryos toward pregnancy and in assessing the outgrowth of ovarian cancer at its native site of formation and detachment. By combining optical coherence tomography (OCT) and an intravital window, this dissertation established detailed approaches for in vivo imaging of the oviduct dynamics and ovarian cancer outgrowth in the mouse model, providing mechanistic insights into the oviduct transport function and laying the groundwork to elucidate the tumor outgrowing activity from the ovary.

For analyzing the embryo transport process inside the oviduct, a range of OCT-based imaging methods were utilized, including functional imaging of the oviduct cilia beat frequency and smooth muscle contraction, as well as 4D (3D+time) imaging of the movement of preimplantation embryos as they develop in the oviduct. The results uncovered that the oviduct is a leaky peristaltic pump in transporting embryos to the uterus. In particular, the embryos experience bidirectional movements driven by the oviduct muscular activity, where the oviduct peristalsis produces the forward embryo movement, while the oviduct relaxation at earlier contraction sites generates the backward embryo movement. Prolonged imaging also revealed how the oviduct creates the net forward displacement of embryos to effectively transport them toward the uterus over a longer period. These findings provide a fundamental understanding of oviduct biomechanics and indicate the direction for identifying the functional cause of embryo retention inside the oviduct, a prerequisite of tubal ectopic pregnancy.

For high-resolution assessment of the ovarian cancer outgrowth, 3D OCT imaging of the ovary was performed with transgenic mice that develop spontaneous ovarian cancer. The results revealed the detailed tissue structures of the outgrowths at different stages of cancer progression on the ovary, presenting their major morphological differences from the normal ovary. The imaging also showed the detached outgrowths and the fluid-filled chambers inside the tumor, indicating their volume heterogeneities. This imaging capability opens the avenue for studying the spread of ovarian cancer at a high resolution in vivo.