Name: Zihan Wang, Anke Klingner, Veronika Magdanz, Merijn W. Hoppenreijs, Sarthak Misra, Islam S. M. Khalil **Email:** z.wang04@umcg.nl
Department: Surgical Robotics Laboratory, Department of Biomedical Engineering, University of Groningen and University Medical Center Groningen, Groningen 9713 GZ, The Netherlands
Presentation Title: Flagellar Propulsion of Sperm Cells Against a Time-Periodic Interaction Force

Abstract:

Sperm cells undergo complex interactions with external environments, such as a solid-boundary, fluid flow, as well as other cells before arriving at the fertilization site. Most healthy sperm cells can overcome these interactions and achieve fusion with the ovum, whereas the abnormal sperm cells with poor swimming performance are filtered out by these selection mechanisms. In this work, we study the influence of a time-periodic interaction force on wave-patterns of bovine sperm cells *in vitro*. The time-periodic interaction force is produced during the formation of collinear bundles. These bundles, consisting of two cells, generate propulsive thrusts along opposite directions and allow us to observe the influence of cell-to-cell interaction on wave-patterns. We develop an elasto-hydrodynamic model to study the interaction of two cells. During the interaction, two cells on a converging course are affected by hydrodynamic, steric, and adhesive forces. Our model demonstrates that steric and adhesive forces lead to highly symmetrical wave-pattern and reduce bending amplitude of the propagating wave. We measure the flagellar propulsion of free sperm cells and cells in the collinear bundle, and find that the free cells exhibit mean flagellar curvature of 6.4 ± 3.5 rad/mm and the bending amplitude of 13.8 ± 2.8 rad/mm in SP-TALP solution. After forming the collinear bundle, the mean flagellar curvature and bending amplitude are decreased to 1.8 ± 1.1 rad/mm and 9.6 ± 1.4 rad/mm, respectively. Our work presents consistent theoretical and experimental results important for understanding the adaptive behavior of sperm cells to the external time-periodic force encountered during sperm-egg interaction. It provides additional insight into how to select sperm cells with high motility, which can be further utilized for *in vitro* fertilization.