



## Development of Multivalent Contraceptive Antibody and Versatile Vaginal Delivery Platforms for Female Reproductive Health

**Samuel K. Lai**

*Division of Pharmacoengineering and Molecular Pharmaceutics, Eshelman School of Pharmacy,  
University of North Carolina-Chapel Hill, Chapel Hill, NC 27599, USA*

### Abstract:

Nearly half of all pregnancies in the U.S. are unintended, and most occur in women who are not using contraceptives. Inadequate user adherence is a major driver of failures in contraception, and underscore the sore need for methods that can afford sustained contraceptive activity. Here, we engineered a novel multimeric monoclonal antibody (mAb) that can effectively agglutinate and trap sperm, and thereby block sperm from swimming through vaginal mucus to fertilize eggs. We further developed a versatile capsule-intravaginal ring (IVR) system that enable sustained release of our contraceptive antibody over 30 days into vaginal fluid simulants in vitro, while fully preserving activity and stability. In vivo, our IVR resulted in comparable sustained release, leading to nearly instantaneously agglutination of all human sperm introduced into the sheep vagina at different times over 22 days, a period that covers the fertility window in most women. We are also developing other platforms including fast-dissolving antibody tablets (FDAT) and multipurpose prevention technologies (MPT) that additionally would prevent sexually transmitted disease (STD) and bacterial infections, such as bacterial vaginosis. Overall, the results demonstrate the effectiveness of our versatile platforms to meet the various needs in female reproductive health.

### Biography:

Since my birth, I have lived around the globe (Tanzania, Singapore, Thailand, Chile, USA, etc.), got my higher educational degrees in USA, and later joined the University of Tokyo as faculty in the Department of Bioengineering. My past achievements include my original research projects on controlling cellular behaviors such as cancer metastasis through geometrical features of microstructured biomaterials that resulted in publications in prominent scientific journals. I have also extensively worked on various areas of bioengineering including microstructured biodevices to isolate and analyze cancer cells, fluorescence/radiation probes for bioimaging and drug delivery to tumors, and creation of polymer-coated artificial lungs. I made a transition from academia to industry, and now serve as the Executive Director of Research in a US biotech startup called Mucommune in North Carolina, where I spearhead various projects in female reproductive health, in particular vaginal products to prevent sexually transmitted diseases and bacterial infections, as well as antibody-based non-hormonal contraception.

### Selected Publications

1. Schaefer A, Kushiro K, ... Lai SK (2025). Engineering Decavalent, Sperm-Binding Laminin-IgG Hybrid Antibodies for Potent Non-Hormonal Contraception. *Advanced Science*. 23:e06272.
2. Kushiro K, ... Lai SK. (2025). Vaginally-delivered fast-dissolving antibody tablets (FDAT) for on-demand non-hormonal contraception and multi-purpose protection. *Journal of Controlled Release*. 382:113662.