This talk will explain how multiple advances in the technology for cell-free protein synthesis (CFPS) may be on the verge of expanding the biopharmaceutical industry.

The era of rRNA biopharmaceuticals was launched using *E. coli* in the early 1980’s to produce proteins such as human insulin (Eli Lilly), human growth hormone (Genentech), granulocyte colony stimulating factor (Amgen), and alpha-interferon (Genentech and Roche). However, as the complexity of the protein pharmaceuticals increased, the industry turned to eukaryotic cells to provide more complex disulfide bond patterns and glycosylation for products such as erythropoietin (Amgen) and tissue-plasminogen activator (Genentech). Further driven by the emergence of monoclonal antibodies as a large family of potent and versatile pharmaceuticals, CHO cells then emerged as the dominant production platform.

Ironically, the need for even more complexity and precision may now be motivating a shift back to prokaryotic systems. Sutro Biopharma, independently and in collaboration with Celgene and Merck Serono, is now developing a new class of antibody drug conjugates (ADCs) produced using *E. coli* cell extracts. They have established GMP manufacturing capability and are nearly ready for human trials. CFPS is providing direct access to the protein synthesis reaction chamber, and that allows the spatially precise introduction of uniquely reactive, non-natural amino acids. This, in turn, enables the precise localization of an exact number of drug molecules per antibody. It also speeds up the production and screening of many ADC candidates so that safety and efficacy can be more effectively optimized. While the jury is still out, such products may be the wave of the future.

This presentation will summarize the technology foundation being used by Sutro. It will then go on to describe how this platform is being further strengthened so even more complex pharmaceutical targets can be approached. As an example, the development of a novel drug targeting technology will be described. It is based on a multiply-modified Virus-like Particle (VLP) based on the core capsid of the hepatitis B virus.

Even though the concept of the magic bullet for targeted drug delivery was proposed by Paul Ehrlich more than 100 years ago, we are still waiting; and there are good reasons for multiple past disappointments. We have now learned that a successful drug delivery vehicle must accept and retain hundreds of cargo molecules while remaining stable during production, storage, and administration. It must then avoid immune system surveillance, trigger internalization into only the targeted cell type, escape from the endosomal vesicles, and finally, for optimal efficacy, it must release its cargo into the cytoplasm. Combining all of these functions into a single nanoparticle has proven to be extremely difficult. This talk will explain how the design freedoms and production efficiencies offered by CFPS may finally allow Ehrlich’s dream to be realized. If so, precisely targeted drug and nucleic acid delivery would allow a much broader range of molecules to be developed as therapies for many different diseases.