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Optogenetics in Bioproduction — Now you can

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EXECUTIVE SUMMARY

Optogenetics is promising precise, non-invasive control of cellular functions, but its adoption in cell-based bioproduction has up to now remained out of reach due to limitations in performance, stability, and scalability. Our latest light-responsive systems show performance advances that make it now ready for industrial application, enabling robust, tunable protein production and dynamic, adaptive manufacturing in standard mammalian workflows.

PROBLEM

The biopharmaceutical industry faces a rising demand for complex biologics, from multi-specific antibodies to viral vectors and therapeutic cells. Optogenetics enables dynamic, light-controlled transcription, but until recently lacked the dynamic range, stability, and compatibility with mammalian cell lines required for industrial applications. Earlier systems were often developed in microbial models or relied on cofactors absent from standard mammalian culture media, limiting their applicability to bioprocess settings.

UNLOCKING LIGHT-CONTROLLED BIOPRODUCTION

We have developed proprietary light-controlled expression systems that overcome the limitations previously hindering optogenetics from industrial use. The latest version improves expression strength by tenfold, while at the same time allowing more than 500-fold in induction of gene expression. This system enables strong, tunable expression of monoclonal and bispecific antibodies in HEK and CHO cells, establishing optogenetics as a reliable, scalable, and controllable approach for bioproduction based on mammalian cells.

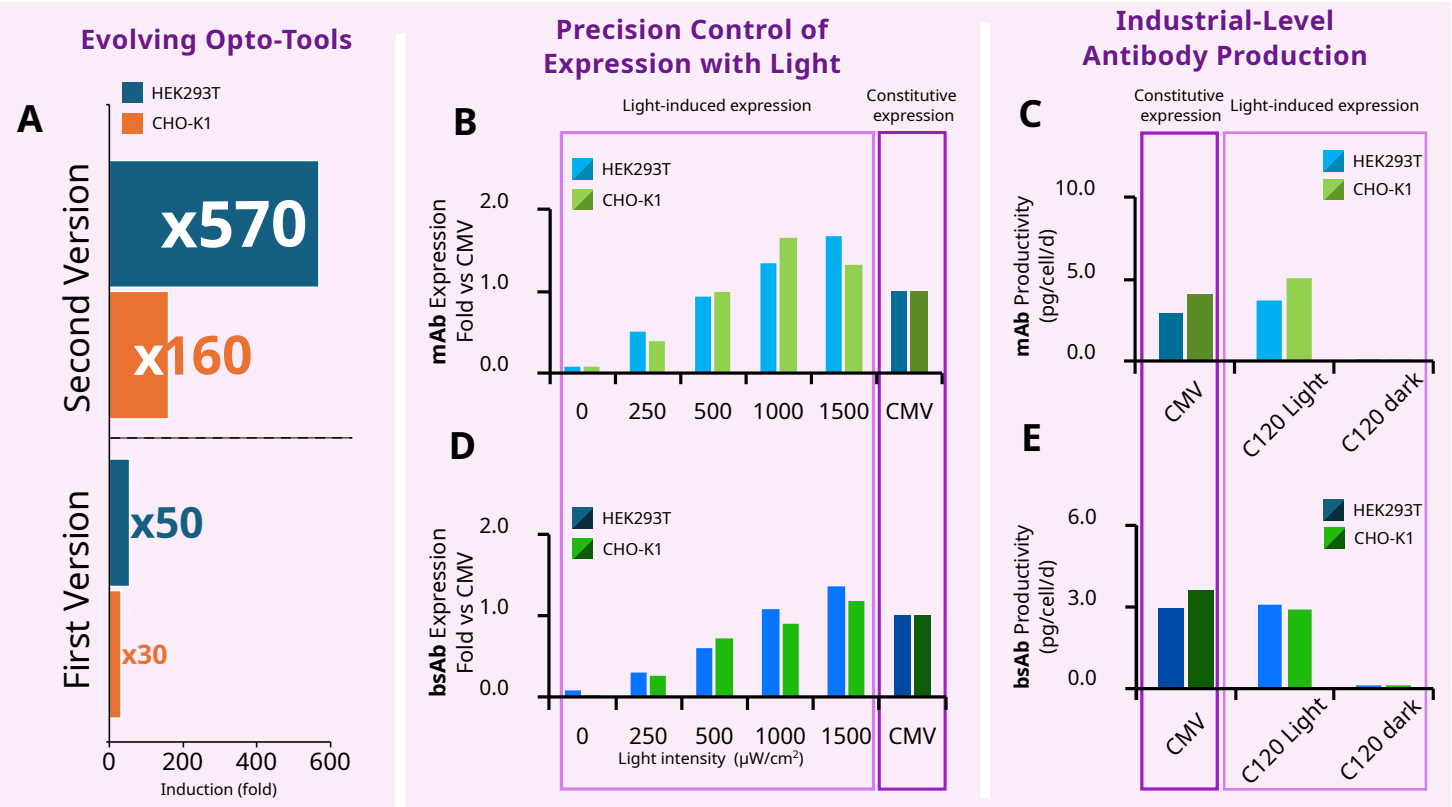

Figure 1. Evolution and performance of the light-controlled expression platform. (A) Successive optogenetic versions of EL222 expressing luciferase, with the new achieving >500-fold induction and a 10-fold gain in expression strenght as compared to the first version. (B, D) Light-tunable expression of monoclonal (B) and bispecific (D) antibodies in HEK and CHO cells, shown as fold change relative to CMV across increasing light intensities. (C, E) Antibody productivity (pg/cell/day) at defined light conditions after 24 h, measured by ELISA. The system delivers robust, reproducible performance across both cell lines (HEK293T blue; CHO-K1 green), confirming suitability for bioproduction. Bars show averages from three replicates across five independent experiments (n=5). Continuous blue light (470 nm) was applied for 24 h at indicated intensities (B, D) or 1500 µW/cm² (C, E).

CONCLUSION

By merging high expression potency with precise, reversible transcriptional control, our next-generation optogenetic platform redefines what is possible in bioproduction. The technology bridges the gap between research innovation and industrial application, offering a foundation for controlling production outcomes in mammalian cells on a completely new level. Optogenetics in bioproduction is no longer a vision, it is ready to transform how complex biopharmaceuticals are made.