Lighting Up Gene Editing: The GlowCas9 Story

Imagine watching gene editing happen in real time—like seeing a molecular surgeon at work, cutting and healing the DNA of living cells with glowing precision. That's exactly what scientists at the Bose Institute, under the leadership of Dr. Basudeb Maji, have accomplished with GlowCas9—a groundbreaking CRISPR tool that literally lights up as it edits genes, recently published in *Angewandte Chemie International Edition*. (https://doi.org/10.1002/anie.202511707).

The CRISPR-Cas9 system, often described as "genetic scissors," has revolutionized medicine by allowing scientists to precisely correct faulty genes. However, one long-standing challenge has been tracking where and when Cas9 acts inside the body. Conventional antibody-based methods can detect Cas9 but only after the cells are fixed or destroyed—making real-time monitoring impossible.

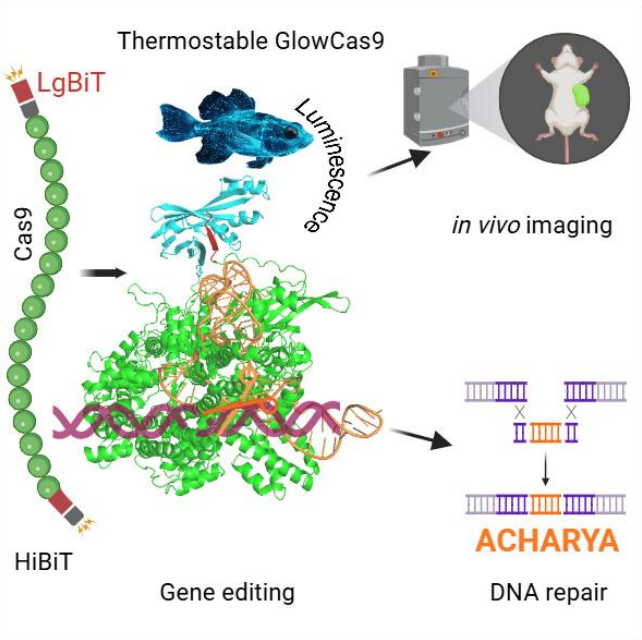
The GlowCas9 system changes that. The lead author, Arkadeep Karmakar, a Ph.D. student under Dr. Basudeb Maji, ingeniously fused Cas9 with a split nano-luciferase enzyme—the same type of light-producing protein found in deep-sea shrimp. When the two split luciferase fragments on either end of Cas9 come together, they reassemble into a working enzyme that emits a bright glow like the fireflies on the trees in the dark night. This light allows scientists to "see" Cas9 activity inside living cells, tissues, and even plant leaves without disrupting the system.

Beyond its glow, the engineered protein is remarkably thermostable—it withstands heat and remains intact longer than conventional wild-type Cas9. This feature is crucial for future gene therapies, where enzyme stability can make the difference between success and failure. The GlowCas9 also demonstrated superior precision in homology-directed repair (HDR), a DNA repair process vital for fixing genetic mutations linked to diseases like sickle cell anemia and muscular dystrophy. As a tribute to Acharya Jagadish Chandra Bose, the pioneering founder of the Bose Institute, the team used GlowCas9 to precisely insert the DNA sequence "**ACHARYA**"—a glowing nod to the institute's enduring legacy in scientific innovation. Perhaps most exciting, the team showed that GlowCas9 could be tracked even inside plant leaves, hinting at its potential in agriculture for safe, non-transgenic gene editing.

By turning the world's most powerful genome editor into a glowing, self-reporting system, GlowCas9 represents a leap forward in *theratracking*—the ability to visualize therapeutic

action in real time. It brings us closer to a future where scientists not only edit genes but also watch the cure unfold, one photon at a time.

Reference: Arkadeep Karmakar, Arpita Hota, Sadiya Tanga, Vivek Kumar, Pallabi Das, Anitha Eswari S, Mala Thapa, and Basudeb Maji*. Engineered Thermostable Chemically Responsive GlowCas9 System for Real-Time Therapeutic Monitoring Applications. *Angewandte Chemie International Edition*, **2025**, https://doi.org/10.1002/anie.202511707.



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