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CRISPR: A Revolution of genome-editing technology

Programmable DNA nucleases like zinc finger nucleases (ZFNs) and transcription activator-like effector nucleases (TALENs) have significantly advanced the field of genome engineering. However, the CRISPR-Cas system, a newer genome-editing method, has gained widespread prominence due to its simplicity, efficiency, and ease of design. First identified by Yoshizumi Ishino during bacterial studies, CRISPR-Cas functions as part of bacteria's adaptive immune system, using the Cas9 enzyme and guide RNA to target and cleave specific DNA sequences. CRISPR-Cas is classified into Class I and Class II, with various subtypes under each class. In biotechnology, Class II, especially types II and V, are particularly valued. The key gene in Class II is Cas9, composed of the recognition (REC) lobe and the nuclease (NUC) lobe. The NUC lobe includes the RuvC, HNH, and Protospacer Adjacent Motif (PAM) interaction domains. Nobel laureates Jennifer Doudna and Emmanuelle Charpentier refined Cas9 into a simpler two-component system by combining two RNA molecules into a single-guide RNA, which, when paired with Cas9, can accurately locate and cut DNA as specified by the guide RNA. CRISPR delivery methods include Physical Delivery Methods (such as microinjection, electroporation, and hydrodynamic techniques), Viral Vector Methods (using adeno-associated virus, lentivirus, and adenovirus), and Non-Viral Methods (including lipid nanoparticles, cell-penetrating peptides, and gold nanoparticles). Of these, Physical Delivery Methods are the most commonly used. CRISPR-Cas9 offers several advantages over other gene-editing approaches, including the ability to target multiple genes simultaneously, high accuracy, low cost, and straightforward design. In the future, CRISPR technology holds the potential to restore species, develop new and healthier foods, and possibly eradicate some of the world's most dangerous pests.

Keywords: CRISPR; genome editing; cas 9; delivery methods; nucleases; immune system.

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