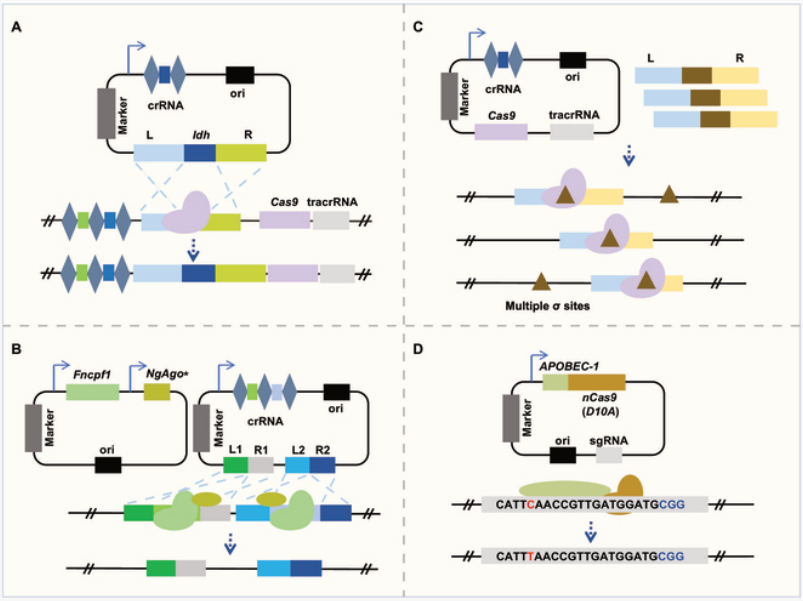
Making Probiotics More Widely Applicable through ‘CRISPR’ Engineering

Scientists review the recent progress and challenges in the production and use of genetically modified probiotics



CRISPR-based genome editing in probiotics.

CHINA, December 11, 2023 /EINPresswire.com/ -- Probiotics are microorganisms that upon consumption, influence the gut microbiome, providing health benefits. Over the past decade, CRISPR-based tools have been used to genetically engineer probiotics, to enhance their effects and introduce new therapeutic functions. In a recent review article, researchers from China summarize the latest progress in this flourishing field, as well as ongoing challenges and strategies for surpassing them.

Humans can benefit significantly from symbiotic relationships with probiotics—live bacteria and microorganisms that influence the gut microbiota. When consumed in appropriate amounts, probiotics can promote gut health, support the immune system, and enhance metabolism.

Probiotics, widely regarded as a treasure in the field of microbiology, are currently finding new applications in medicine, animal care, and the food industry. However, it is often challenging to use probiotics in their existing form, owing to varying effects of different strains on the health of different individuals. Consequently, finding concrete evidence to support the proposed benefits of probiotics is also difficult.

Fortunately, these challenges can be addressed owing to the tremendous progress that we have witnessed in genetic engineering over the past decade, especially after the introduction of the immensely popular CRISPR-Cas editing system. By editing, deleting, or introducing specific genes with these tools, we can tailor the activities of probiotic organisms to fit our health needs. To support the researchers interested in pushing the limits of the field, Professor Nan Peng from

the Huazhong Agricultural University, China, along with his colleagues, recently published a review article in Volume 5 of BioDesign Research on September 29, 2023, summarizing the latest advances and hurdles related to the engineering of probiotics with CRISPR-Cas. “As important genome editing tools, CRISPR-Cas systems have opened the window to new improvements in genome editing dedicated to probiotics thanks to their high efficiency, flexibility, and specificity,” remarks Prof. Peng.

The review begins with a concise overview of CRISPR-Cas systems discovered in microorganisms. In their natural forms, CRISPR-Cas systems are defense tools for bacteria against viruses/phages. When a bacterium survives a viral attack, it stores some viral DNA in the form of CRISPR sequences. If the same virus appears again, the bacterium produces ‘guide RNA’ molecules based on the CRISPR sequences stored as memories. These molecules guide Cas proteins, which act like molecular scissors, to cleave and neutralize the targeted viral DNA. Over time, scientists have found methods to leverage these molecular mechanisms as toolkits for precise gene editing.

In subsequent sections, the research team summarized the key CRISPR-Cas systems that are used to edit genes in several types of probiotic organisms. These include lactic acid bacteria, yeast, Bacillus, and others. Subsequently, they highlighted recent developments on the therapeutic applications of probiotics that were genetically modified through the CRISPR-based systems. “The intake of probiotics has been gradually demonstrated as an effective strategy to prevent or mitigate diseases in humans. Among various probiotics evaluated, genetically modified probiotic strains can have stronger or new properties and exhibit greater research and application value,” states Prof. Peng. Certain examples include the use of Escherichia coli (E. coli) to eliminate antibiotic-resistant bacteria in the gut and protect it against harmful E. coli infections, the use of yeast to treat inflammatory bowel disease, and the use of Bacillus subtilis to regulate metabolism and help prevent obesity.

Finally, the article presents unsolved issues for the CRISPR-based genetic modification of probiotics and the obstacles to their clinical application, alongside potential strategies to address them. A few of these strategies include the development of CRISPR tools to reduce errors during cleaving and gene insertion, optimization of the editing system, using alternative Cas9 proteins (such as dead-Cas9), and ensuring the stability of engineered strains. “Undoubtedly, the use of engineered probiotics to promote the development of animal and human health industries will face great opportunities and challenges in the future,” concludes Prof. Peng, optimistic about what could be just over the horizon in this exciting and flourishing field.

Let us hope that these research efforts allow us to lead healthier lives sooner rather than later!

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