Innovative double-layer polysaccharide hydrogel shows promise for intestine-targeted oral delivery of probiotics

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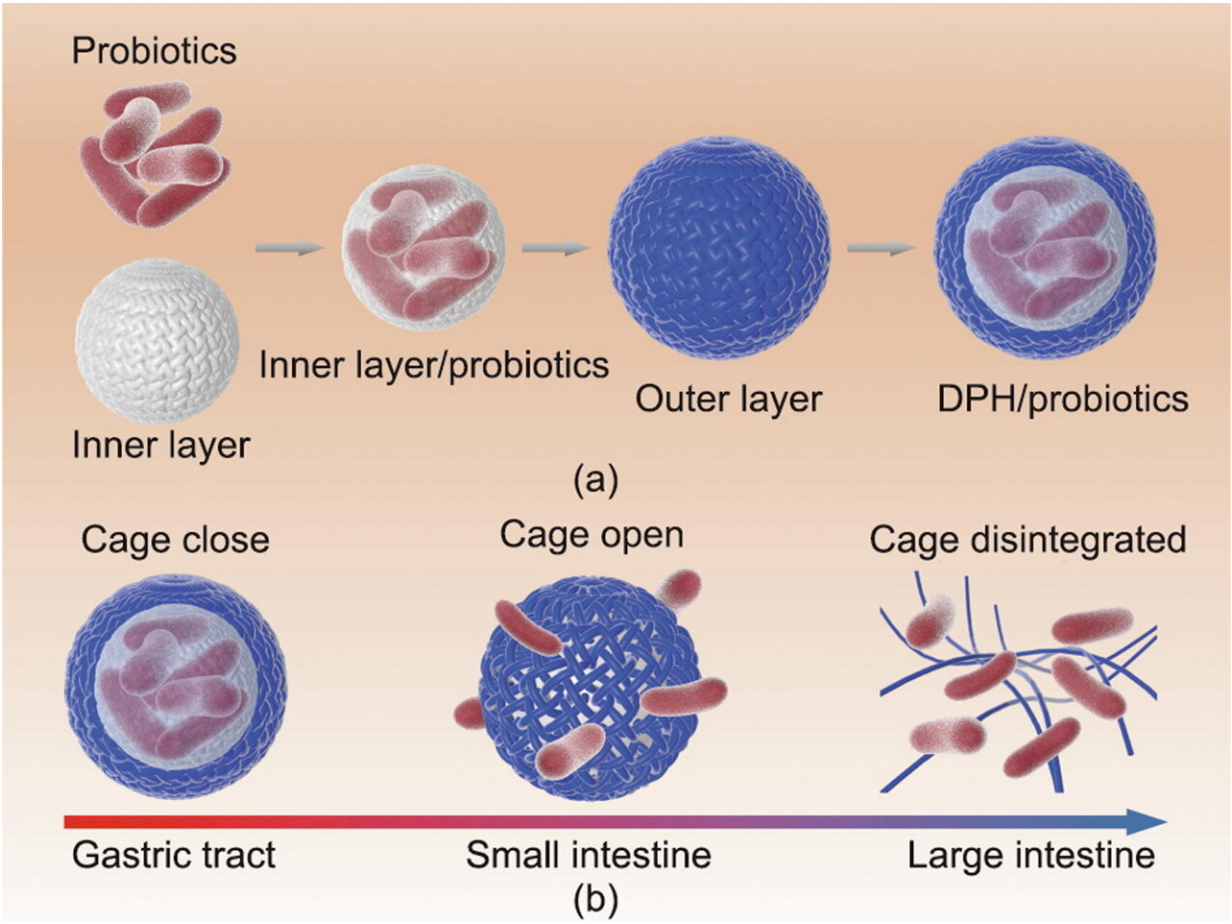

(a) Design rationale of the DPH; (b) mechanism of intestine-targeted delivery. Credit: Wen-Can Huang et al.

A research team led by Changhu Xue and Xiangzhao Mao from the Ocean University of China has developed a remarkable double-layer polysaccharide hydrogel (DPH) that promises to revolutionize the field of intestine-targeted oral delivery of probiotics. The team's findings, titled "A Double-Layer Polysaccharide Hydrogel (DPH) for the Enhanced Intestine-Targeted Oral Delivery of Probiotics" and published in *Engineering*, demonstrate the potential of DPH to enhance the bioavailability, intestinal colonization, and overall effectiveness of probiotics in treating various diseases.

The research team's study focused on addressing the challenges posed by the harsh gastrointestinal environment and the short retention time in the gastrointestinal tract, which significantly limit the efficacy of probiotics. By harnessing the unique properties of DPH, the team successfully encapsulated and delivered probiotics in a targeted manner within the body.

DPH, composed of a carboxymethyl cellulose (CMCL) supramolecular inner layer and a dialdehyde alginate (DAA) cross-linked carboxymethyl chitosan (CMCS) outer layer, exhibits a double-layer structure that plays a crucial role in protecting probiotics throughout the gastrointestinal journey. In the stomach, the cage-like structure of DPH remains closed, forming a barrier that shields the probiotics from gastric fluids. However, upon reaching the intestine, the cage structure opens and disintegrates, releasing the probiotics precisely where they are needed.

The results of the study are truly remarkable. Probiotics encapsulated by DPH demonstrated a staggering 100.1 times-higher bioavailability and 10.6 times-higher mucoadhesion compared to free probiotics in an animal model 48 hours post-treatment. Furthermore, DPH exhibited exceptional mucoadhesive properties, allowing for improved colonization in the intestinal tract and enhanced survival in the extreme conditions of the gastrointestinal tract while maintaining the viability and

activity of the probiotics.

One of the key innovations of the DPH hydrogel is the dynamic crosslinking facilitated by DAA, which not only ensures the overall integrity of the hydrogels but also controls the timing of probiotic release. This breakthrough opens up new possibilities for delivering encapsulated substances, such as probiotics and proteins, to specific sites within the intestinal tract.

The potential applications of DPH extend beyond its role in enhancing the delivery of probiotics. The study also validated the structure, morphology, biocompatibility, controlled-release behavior, and bacterial competition of the DPH hydrogel, suggesting its potential as a versatile carrier for targeted delivery in various biomedical applications.

"The development of the double-layer polysaccharide hydrogel marks a significant milestone in the field of intestine-targeted oral delivery of probiotics," said Shasha Zhao, editor of *Engineering*. "We anticipate that DPH will serve as a game-changer, offering a promising alternative to existing carriers and significantly improving the efficacy of probiotics in treating a wide range of diseases."

These findings pave the way for further research and development in the field of targeted drug delivery and open up new possibilities for improving the effectiveness of probiotics in promoting gut health and treating various diseases.

The paper is authored by Wen-Can Huang, Wenjie Wang, Wei Wang, Yanan Hao, Changhu Xue, Xiangzhao Mao.

More information: Wen-Can Huang et al, A Double-Layer Polysaccharide Hydrogel (DPH) for the Enhanced Intestine-Targeted Oral Delivery of Probiotics, *Engineering* (2023). DOI:

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