Polymers that kill germs rapidly and effectively will help in the fight against multidrug-resistant microbes

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Inexpensive antimicrobial polymers that are gentle on the skin and highly effective in killing microbes have been developed by A*STAR researchers1. They have promise for use in surgical scrubs and disinfectants.

Most antibiotics work by disrupting the specific biochemical pathways microbes use to make the proteins and enzymes which are essential for their survival. This strategy makes them lethal to microbes but safe to the cells of humans and other mammals. However, it is easy for microbes to develop resistance to such antibiotics, which has led to the widespread problem of multi drug-resistant microbes.

The antimicrobial compounds of the body's immune system use a different tactic—they fight microbes by destroying their membranes. Since this approach is based on the inherent electrical properties of the cell membrane, it is much harder, if not impossible, for microbes to develop resistance.

Now, Yi Yan Yang of the A*STAR Institute of Bioengineering and Nanotechnology and her co-workers, in collaboration with IBM Almaden Research Center, have developed powerful antimicrobial polymers that employ the same strategy. The polymers with optimized structures killed almost 100 per cent of microbes within two minutes. They were also softer on the skin of mice than commercial surgical

scrubs that are currently used in clinical settings.

"Our polymers kill a broad spectrum of microbes, especially the difficult-to-kill Pseudomonas aeruginosa, faster than any of the many antimicrobial peptides and polymers reported to date," comments Yang. "With their superfast bactericidal effect and skin compatibility, these polymers are promising candidates for use as surgical scrubs, hand washes and disinfectants," she adds.

The polymers have two key components: positive charges and hydrophobic parts. Their positively charged components interact with the negatively charged membranes of pathogenic microbes, while the hydrophobic parts of the polymers enter the two layers of fat cells inside membranes. This double action ruptures the membrane and destroys the microbe. Since the surfaces of mammalian cells are less negatively charged than those of microbes, cells such as red blood cells are immune to the polymers' action.

The researchers found that repeated use of the polymer at sub-lethal doses did not lead to bacterial resistance. In addition, the polymers are inexpensive to make and can be synthesized from commercially available starting materials.

"Building on this work, we are developing biodegradable versions of the polymers," says Yang. "They are designed to degrade into benign, environmentally-friendly compounds. Such biodegradable antimicrobial polymers may be used as preservatives in cosmetics and even food products."

More information: Shaoqiong Liu et al. Highly potent antimicrobial polyionenes with rapid killing kinetics, skin biocompatibility and in vivo bactericidal activity, *Biomaterials* (2017). DOI: 10.1016/j.biomaterials.2017.02.027

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