Scientists just created a flexible bio-glue for healing wounds

Scientists have developed a super strong, flexible adhesive material inspired by the glue secreted by slugs that sticks to biological tissues – even when wet – without causing toxicity. The "tough adhesive" is biocompatible and binds to tissues with a strength comparable to the body's own resilient cartilage, researchers said.

"The key feature of our material is the combination of a very strong adhesive force and the ability to transfer and dissipate stress, which have historically not been integrated into a single adhesive," said Dave Mooney, professor at Harvard University's Paulson School of Engineering and Applied Sciences (SEAS) in the US.

Slugs secrete a special kind of mucus when threatened that glue it in place, making it difficult for a predator to pry it off its surface.

This glue was previously determined to be composed of a tough matrix peppered with positively charged proteins, which inspired Jianyu Li, an assistant professor at McGill University in Canada and colleagues to create a double-layered hydrogel consisting of an alginate-polyacrylamide matrix supporting an adhesive layer that has positively-charged polymers protruding from its surface.

The polymers bond to biological tissues via three mechanisms – electrostatic attraction to negatively charged cell surfaces, covalent bonds between neighbouring atoms, and physical interpenetration – making the adhesive extremely strong.

"Most prior material designs have focused only on the interface between the tissue and the adhesive. Our adhesive is able to dissipate energy through its matrix layer, which enables it to deform much more before it breaks," said Li.

The team's design for the matrix layer includes calcium ions that are bound to the alginate hydrogel via ionic bonds. When stress is applied to the adhesive, those "sacrificial" ionic bonds break first, allowing the matrix to absorb a large amount of energy before its structure becomes compromised.

In experimental tests, more than three times the energy was needed to disrupt the tough adhesive's bonding compared with other medical-grade adhesives. When it did break, what failed was the hydrogel itself, not the bond between the adhesive and the tissue, demonstrating an unprecedented level of simultaneous high adhesion strength and matrix toughness.

The researchers tested their adhesive on a variety of both dry and wet pig tissues including skin, cartilage, heart, artery, and liver, and found that it bound to all of them with significantly greater strength than other medical adhesives.

The tough adhesive also maintained its stability and bonding when implanted into rats for two weeks, or when used to seal a hole in a pig heart that was mechanically inflated and deflated and then subjected to tens of thousands of cycles of stretching.

It also caused no tissue damage or adhesions to surrounding tissues when applied to a liver hemorrhage in mice – side effects that were observed with both super glue and a commercial thrombin-based adhesive.

Such a high-performance material has numerous potential applications in the medical field, either

as a patch that can be cut to desired sizes and applied to tissue surfaces or as an injectable solution for deeper injuries. The research was published in the journal Science.

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