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Scientists create super biomaterials from squids, mussels and sea snails

(*Nanowerk News*) Scientists from Nanyang Technological University (NTU) and Singapore's Agency for Science, Technology and Research (A*STAR) have developed new biomaterials, such as one from squid's sucker ring teeth that is harder, more rigid and more wear-resistant than conventional plastics.

This breakthrough is made possible by the use of a new interdisciplinary approach which integrates RNA sequencing and proteomics - the study of functions, structures and the interactions of proteins - with material science.

Published this week in *Nature Biotechnology* ("Accelerating the design of biomimetic materials by integrating RNA-seq with proteomics and materials science"), the world's top international scientific journal in the field, this ground-breaking work now allows scientists to speed up the discovery and development of new and better biomaterials within months instead of years.

The squid sucker ring teeth is just one of the three biomaterials that NTU and A*STAR scientists have studied in the past year. The other two discoveries include sticky underwater glue which is derived from mussels and an extremely elastic material from sea snails' egg capsules.

The squid-inspired biomaterial can be made into biocompatible films for food and drug packaging, and as cost-effective encapsulants to protect expensive drugs against heat and impact during transportation and storage. Such new biomaterials can be used for a wide number of applications, even as parts for organ implants, as they are versatile and easily processed into different shapes and forms.

These new biomaterials are superior, if not comparable with those produced from petroleum-based polymers, yet are made using eco-friendly processes without using harsh chemicals. This study further accelerates the understanding of nature's design and aims to find new materials for the future which are more sustainable than today's plastics.

NTU Assistant Professor Ali Miserez, who co-led this research with his colleague Dr Paul Guerette and A*STAR scientist Dr Shawn Hoon, said the new approach of integrating proteomics and material science holds great potential for industry and researchers.

"Nature has many secrets which we have yet to uncover. This new biomaterial made from squid's sucker ring teeth – which are a set of razor sharp teeth found on squid tentacles used to latch on to prey - can retain its property when wet. It could be a new solution to wear-resistant human implants that are exposed to water on a continuous basis. By comparison, silk – which is similar to the material we discovered in terms of molecular structure – is exceptionally strong when dry, but becomes weak when exposed to water," Asst Prof Miserez said.

"The potential of finding new biomaterials in such a short time is immense. By understanding the structure of the protein in the sucker rings, we were able to reproduce the protein artificially and engineer materials with impressive rigidity, hardness and wear-resistance. This will lead to new types of sustainable bio-materials made from proteins."

Dr Shawn Hoon, Research Fellow at A*STAR's Molecular Engineering Lab said, "Both biological and material sciences have developed very sophisticated techniques for characterisation in their respective fields and our work demonstrates that by integrating these technologies, discoveries can be accelerated. What we are ultimately trying to achieve is to understand the 'building principles' of natural materials. We think our success will be very instructive for material scientists looking to biological materials for inspiration."

"Hundreds of millions of years of evolution has resulted in a superb array of functional materials worth mimicking," said Dr Paul Guerette, a Senior Research Fellow in the School of Materials Science and Engineering at NTU. "Our work demonstrates that for natural materials systems, the scope and depth of information we can access is now very large. We offer a clear pathway to translate this knowledge, with unprecedented speed, into the creation of an extreme range of novel materials with many real world applications."

Nobel Laureate Sydney Brenner, one of the pioneers in molecular biology, said: "The Molecular Engineering Laboratory in A*STAR was founded to encourage young Singaporean scientists to generate original research in areas at the interface of physics, chemistry and biology."

"I am delighted that Dr Hoon and his collaborators have fruitfully applied modern methods of molecular biology to produce this important paper in materials science," added Professor Brenner, who had received the Nobel Prize in Physiology or Medicine in 2002.

First bio-materials database in Singapore

To achieve a greater understanding of nature's materials, the scientists are developing the first bio-materials database in Singapore, which would house the detailed characterisations of materials including some that they have identified so far, such as high performance adhesives, elastomers and biocomposites.

"Singapore's biodiversity is a national treasure, and for every species there are libraries of innovative material designs awaiting discovery. Each discovery represents an opportunity to create novel materials with precisely tailored structures and functions," said Dr Guerette.

Going forward, the scientists intend to develop this innovative technique further, discovering and characterising new materials from nature and finding ways to engineer them into new classes of materials that compete with and even surpass Nature's best designs.

Source: *Nanyang Technological University*

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