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A hundred thousand crabs are killed every year for their blood, which keeps the world's vaccines safe for use. Mariquita de Boissière explores how synthetic biology can save their lives.

Set atop long metallic tables are double rows of greyish, insect-legged, crustaceans. They look like they belong to either a distant geological epoch or a faraway galaxy. That's what you get when you pluck crabs from the depths of the Atlantic Ocean.

Tied down with a rubber strap, each is subject to a strange, cruel procedure by which metal tubes extract blue blood from their bodies into glass bottles.

The scene looks like it could come from a film. Labs like this were in *Alien*. But they are also found across the United States, whose Eastern coast, from South Carolina to New Jersey, is the popular habitat for this type of crab.

These strange creatures, which trace their ancestors back 450 million years, will not look familiar, but you'd be hard-pressed to find anyone whose life hasn't been touched by the Atlantic horseshoe crab.

Blood from the Atlantic horseshoe is used to make *limulus amebocyte lysate*, LAL, the vital chemical which ensures that vaccines are free from harmful bacteria. It's been keeping the world's vaccines safe since the 1980s.

Crabs don't bleed to death, but the invasive procedure has a mortality rate of **15%** according to the Atlantic Fisheries Commission that oversees the trade. Other research, however, has put the true figure as high as **30%**, according to Dr. Rich Gorman, a Research Fellow at the University of Sussex. Over half a million crabs are bled like this every year. Around 100,000 lose their lives.

"During the pandemic," Rich tells me, "people couldn't believe that, in 2020, the entire medicine industry relied on the blood of a wild-caught crab that only lives in parts of the North American coast."

But the trade of animal lives for human medicines is looking close to an end. Modern progress in synthetic biology, which lets scientists grow and genetically modify cells, means that an alternative to LAL is now affordable and viable at scale. Known as recombinant factor C (rFC), the synthetic substance was first created in 2003. No crabs required.

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— Dr. Rich Gorman, Research Fellow, University of Sussex, UK

Today's mission, Rich explains, is for rFC to prove itself to regulators and pharma companies. "Just because the technology has been developed, it doesn't mean that people will necessarily use it," Rich notes. In addition, a patent held up adoption of rFC until it **expired in 2018**, when it became approved in the European Union. It's also been accepted by the FDA since 2012, but there's no formal guidance on how to use it yet in the United States.

Synthetic materials like rFC are increasingly coming into vogue. Albert Anis, co-founder of ValleyDAO, a decentralised funding organisation for synthetic biology research, recommends that I see the idea as "biology-as-a-technology."

Drawing a parallel between synthetic biology and computer programming, Albert explains the field in the following terms: just as computer programs are built on binary code (1s and 0s), synthetic biology is founded on the four chemical bases of DNA: Adenine (A), Cytosine (C), Guanine (G), and Thymine (T). Albert compares this genetic code to "the programming language of life."

Albert Anis, a researcher and founder of funding organisation ValleyDAO, believes that "synthetic biology can make our prosperity sustainable by producing the essential materials that make the world go around."

Swedish-born, the scientist has built his career on the idea that synthetic biology can solve some of the world's most pressing problems. "Software lets us create insights from digital zeros and ones, but we haven't yet figured out how to do this for the physical realm," he says. "Why are we in a climate crisis? Why are we still dependent on petrochemicals? We need to build technology that can deliver our material needs sustainably."

Albert's Masters' thesis explored how to convert carbon dioxide, a polluting greenhouse gas, into fuel. He explains that the natural world is full of organisms that act like "biological factories", producing materials that we rely on whilst sustaining our global ecosystem. Not only horseshoe crabs. Yeast, fungi, and trees are just a handful of the naturally occurring entities that power our environmental cycle.

As humans have spread across the planet, these cycles failed to keep up. Our environmental equilibrium has been thoroughly disrupted. But new approaches let humanity design alternative ways to create the materials we need, and at less cost to our natural world. As Albert puts it, "synthetic biology can make our prosperity sustainable by programming microorganisms at the genetic level, producing the essential materials that make the world go around."

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