Can Synthetic Biology Bridge the Protein Gap?

By bioscentric | Biology

You've probably heard the numbers before, which usually play on estimates from the U.N. that call for the world's population to grow from roughly 7.4 billion today to nearly 9.7 billion by the year 2050. Therefore, the argument goes, biotech will be needed more than ever to provide more with less. More cures. More food. More *more*.

One challenge posed by the world's swelling population — and swelling middle class specifically — is our ability to produce protein. Fears of future undersupply are neatly summed up as the "protein gap". Consider that higher living standards are accompanied by higher calorie intake per capita, as evidenced by World Health Organization data. WHO estimates that global daily per capita calorie intake stood at 2,358 in 1964, when 3.2 billion individuals inhabited the planet, and will rise to 3,050 by 2050. If both the U.N. and WHO are correct, then the human race will consume 22,000-billion calories more each day by mid-century than it did when Beatlemania swept through America. That's the equivalent of 39 billion Big Macs.

Addressing this challenge offers opportunity, as some of the world's largest companies have singled out the protein gap as a source of future growth, while a new crop of engineered biology companies are dedicating their efforts to developing cultured meat technology platforms. The latter are taking aim at the assumed inefficiency of growing animal protein.

Raising livestock *does* require enormous amounts of land, water, energy, and food. However, cultured meat technology is still many years away from becoming a market reality. Paradoxically, current cultured meat production methods require animal growth factors such as bovine serum, albumin, and antibiotics, and no reliable process is close to being scaled to industrial levels of production. For now at least, it seems animals are the most efficient way to grow animal cells.

So if lab grown meat is probably still resource intensive and animal reliant, what can engineered biology do in the short and medium term to bridge the protein gap? The answer might be that biology platforms are really better suited currently to enhancing existing alternative proteins, such as soy and pea varieties, rather than recreating meat in a lab. Engineered biology can produce the ingredients, supplements and processing aids that will make these abundant alternative protein sources more compatible with consumer preferences by improving taste, texture, shelf stability, and other product characteristics.

Building a bridge

Consider Impossible Foods. The company has developed — and is currently selling in limited quantities — a vegan burger made from plant proteins that truly acts as a bridge between today's carnivore-driven protein market and one in the future driven by cultured meat products.

On the journey to recreate the texture, taste, aroma, and nutrition profile of a traditional beef burger using only plant-derived ingredients, Impossible Foods discovered that one ingredient in particular really defined the experience of eating cooked ground hamburger: heme. The protein is found in abundance in animal muscle tissues and is also a critical building block in plants. So, the company developed a process to manufacture a plant heme (leghemoglobin) via fermentation, formulate it into a burger, and serve up all of the important characteristics and consumer experiences of ground beef products. Other animal meats, from chicken to turkey to pork, are in the works. So rather than build a new protein source uop from scratch, biotechnology is leveraged to produce the distinctive ingredient, heme, that gives abundant plant proteins a meat-like characteristic.

Similarly, Unilever has leaned on engineered biology to improve the experience of plant-based ice creams. In 2002 the company received a GRAS notice from the U.S. FDA for an ice structuring enzyme that was first identified in the tissue of a deep sea organism. The enzyme affects ice crystal nucleation in frozen product formulations to better control thermal stability, hardness, creaminess, and flavor delivery — characteristics dairy-free ice creams have struggled with.

Industrial biotech platforms in existence today could produce food and feed ingredients — sometimes including proteins themselves — with a much lower land use requirement than current agricultural and livestock production systems. Competing partnerships between TerraVia and Bunge and Synthetic Genomics and Archer Daniels Midland are racing to carve our dominant shares in the bulging market for DHA, a long-chain omega-3 commonly added to fish feed and traditionally sourced from fish such as menhaden. Both groups are relying on industrial microalgae strains to produce the ingredient more efficiently and at a lower price point to relieve pressure on aquaculture markets (the latter's is non-GMO), which are quickly becoming a reliable source of protein consumption in the fastest growing parts of the world.

Strategic options for biotech solutions

The swelling global middle class has already begun to strain resource availability, but the situation could become much more pressing in the near future. While the opportunities at hand are well-suited for biology-based solutions, the industry is better served focusing on the right mix of near- and long-term strategies. Cultured meat may be getting the spotlight and firing our imagination today, but the best opportunities right now for engineered biology firms that want to participate in food and nutrition is to go the route of developing ingredients that make the already abundant and easily accessed alternative proteins taste better, function better, or be more nutritive.

Heme provides a great example. Impossible Foods chose to focus on reproducing the consumer experience of eating a meat burger, and more importantly, the company is able to deliver an uncompromised experience *and* a step change in environmental benefits. One heme-infused burger requires just one-quarter the water, 5% the land, and one-eighth the greenhouse gas emissions to produce compared to a traditional beef burger.

The product shows a better way forward for the field by illuminating two key points. First, credibly reducing production intensity is paramount, and lab grown meat is not currently succeeding there. Second, there's a lot of momentum in abundant alternative proteins from plants, and as these enter supply chains, will need a combination of existing and novel ingredient and processing aids to reproduce the experience of meat, dairy, and other animal products consumers are entrained to love. And that’s a key opportunity area for engineered biology.