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system — or any other network — requires three things to happen. First, researchers need to identify all the players in that system; second, they must work out how they relate to each other; and third, they need to understand and quantify the impact of those relationships on each other and on those outside the system.

Take nutrition. In its latest report on global food security, the United Nations Food and Agriculture Organization says that the number of undernourished people in the world has been rising since 2015, despite great advances in nutrition science. For example, tracking of 150 biochemicals in food by the US Department of Agriculture and various databases has been important in revealing the relationships between calories, sugar, fat, vitamins and the occurrence of common diseases. But using machine learning and artificial intelligence, network scientist Albert László Barabási at Northeastern University in Boston, Massachusetts, and his colleagues propose that human diets consist of at least 26,000 biochemicals — and that the vast majority are not known (*Nature Food* **1**, 33–37; 2020). This shows that we have some way to travel before achieving the first objective of systems thinking — which, in this example, is to identify more components of the nutrition system.

A systems approach to creating change is also built on the assumption that everyone in the system has equal power and status — or agency, to use the academic term. But as health-equity researcher Sharon Friel at the Australian National University in Canberra and her colleagues show, the food system is not an equal one, and the power of world trade can override environmental and nutritional needs (S. Friel *et al. Nature Food* **1**, 51–58; 2020). Countries need to pass relevant laws and regulations to meet global goals for nutrition and climate change. But this becomes difficult because the global trade rules set by the World Trade Organization (WTO) are legally binding on countries, whereas policies on climate change or nutrition are often not.

The need for a global counterweight to the WTO has led to calls for a World Environmental Organization (see, for example, go.nature.com/2th18yc). Another way to redress such power imbalances is for more universities to do what Meadows did and teach students how to think using a systems approach.

A team of researchers has done just that, through the Interdisciplinary Food Systems Teaching and Learning programme (J. Ingram *et al. Nature Food* **1**, 9–10; 2020). Students from disciplines including agriculture, ecology and economics learn together by drawing on their collective expertise in tackling real-world problems, such as how to reduce food waste. Since its launch in 2015, the programme has trained more than 1,500 students from 45 university departments.

More researchers, policymakers and representatives from the food industry must learn to look beyond their direct lines of responsibility and embrace a systems approach, as the editors of *Nature Food* advocate in their launch editorial (*Nature Food* **1**, 1; 2020). Meadows knew that visions alone don't produce results, but concluded that "we'll never produce results that we can't envision".

"The food system is not an equal one."

The life of archaea

Cultivation of Asgard archaea brings us closer to understanding how complex life evolved.

Hilaire Belloc's 'The Microbe' opens with the words:

> The microbe is so very small,
> You cannot make him out at all.

The poem lists the wonders of microorganisms, and they continue to reveal their secrets to researchers more than a century after his book *The Bad Child's Book of Beasts* (1896) excited and delighted children.

In 2015, researchers published the metagenome of a member of the Asgard group of archaea called Lokiarchaeota (A. Spang *et al. Nature* **521**, 173–179; 2015). These are descended from an ancient lineage of archaea, simple cells lacking a nucleus and distinct from bacteria. This discovery was exciting because the genes were found to have similarities with those of eukaryotes — the group of organisms whose cells have nuclei and other structures, and which include plants, fungi, humans and other animals. That suggested a stronger connection between archaea and eukaryotes than had previously been thought.

Now, after a heroic effort that took 12 years, researchers led by Hiroyuki Imachi, a microbiologist at the Japan Agency for Marine-Earth Science and Technology, Yokosuka, have successfully grown a new Asgard lineage (H. Imachi *et al. Nature* https://doi.org/10.1038/s41586-019-1916-6; 2020). This achievement puts to rest concerns that the genes sequenced in 2015 were the result of contamination, or the initial sample being a mix of cells.

Imachi and his colleagues grew cells from sediment that had been collected below the sea bed. But why did the cells take so long to grow? The problem in culturing cells from sediment is that most microbes aren't as obliging as familiar lab workhorses such as *Escherichia coli*. The researchers took up the challenge and with much patience, trial and error, they found that the cells grew best on a diet of peptides, amino acids and even baby-milk powder.

The resulting cells are tiny spheres 300–750 nanometres in diameter, but they often extrude longer, branched filaments that reach out to meet neighbouring bacteria. The researchers think that such a partnership, both biochemical and physical, could tell us more about the processes that led to the eukaryote cell being formed — a question more researchers must surely try to tackle.

Despite the promise of what is to come, a degree of caution is needed. Eukaryotes evolved more than two billion years ago, possibly coincident with an episode of global climatic change called the Great Oxidation Event. Nonetheless, the achievement brings us closer to meeting living relatives of our ancestors. We await the next chapter with anticipation.