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Cell biology

Human proteins delivering mRNA could treat diseases

Michael Le Page

PACKAGING messenger RNA inside a human protein may make it much easier to deliver mRNA to cells in organs. This could allow mRNA to be used to treat conditions from autoimmune disorders to cancers.

The success of the coronavirus vaccines has demonstrated the potential of the mRNA approach. Instead of making proteins in factories, which is difficult and expensive, this method is based on delivering genes and letting the body do the hard work of making proteins.

The mRNAs are copies of genes that don't get integrated into cells' genomes and break down quickly, so their effect is temporary. But delivering genes to cells is tricky. One approach is to package them in the shell of a virus. But the immune system targets the shell, preventing people from being dosed repeatedly.

In the Pfizer/BioNTech and Moderna covid-19 vaccines, mRNA is instead held in oily droplets called lipid nanoparticles, injected into arm muscles. These don't provoke an immune reaction, but if lipid nanoparticles are injected into the bloodstream, they get mopped up by the liver within half an hour. This is ideal for, say, treating protein deficiencies in the liver, but not for treating brain or heart disorders.

Now, Feng Zhang, an investigator at the Howard Hughes Medical Institute who is based in Massachusetts has combined the advantages of both approaches. He and his colleagues have shown that mRNAs can be packaged in a human protein called PEG10 that forms virus-like particles (*Science*, doi.org/grtk).

Using a human protein shouldn't provoke an immune response, so people could be given repeated doses of the same treatment. By adding various targeting proteins to the outside of the particles, mRNAs can be delivered to any desired cell type. ▮

Energy

Solar panels in space could help power the UK by 2039

Adam Vaughan

SOLAR power beamed from satellites could give the UK a continuous supply of green energy as soon as 2039.

The idea of space-based solar power isn't new, but technology developments and climate change concerns have renewed interest in the concept in recent years in China, Japan, the US and, now, the UK.

A report on its economic and technological feasibility, requested by the UK Space Agency, suggests a £16.3 billion development plan could make the concept a reality, and help the UK cut its carbon emissions to meet its 2050 net-zero goal.

The authors say a network of satellites with solar panels could be launched into geostationary orbit. Each would weigh around 2000 tonnes and be about 1.7 kilometres across. The sun's energy would be converted to high frequency radio waves beamed down to a 98-square-kilometre antenna facility resembling a giant fishing net to convert it back to electricity.

Martin Soltau at Frazer-Nash, the consultancy behind the report, told a public meeting on 28 July: "Our overall finding is the technology offers new and viable options for the UK to deliver net zero." He said the benefits strongly outweigh the costs. Under his possible timeline, a small trial in low Earth orbit in the late 2020s could prove that power can be transmitted to the ground, followed by an operational power station in 2039. That facility would have a capacity of about 2 gigawatts, 27 times the biggest solar plant in the UK.

£50

Cost per megawatt-hour for electricity produced in orbit

Unlike terrestrial solar power, its space-based cousin could provide a continuous source of low-carbon power around the clock. Soltau says steady supply will be increasingly important in coming years as the UK shifts its energy supplies to more variable sources of electricity, mainly offshore wind farms.

The high price tag and the long time until investors reap rewards means public money is likely to be needed, Frazer-Nash said in its presentation. But the group says electricity beamed from orbit could be competitive with other sources of continuous low-carbon power, at about £50 per megawatt-hour.

In theory, the technology exists to make the concept work. Nonetheless, Soltau acknowledges there remain major obstacles for the UK. Those include the size of the area needed for the antenna – a challenge on a crowded island like the UK, meaning it could be sited offshore – regulatory issues over the radio frequency needed, and the need for cheap and regular rocket launches.

There is also the issue of the environmental impact of the number of rocket launches needed to establish the solar arrays. Soltau says establishing 25 solar power satellites over 10 years would require near daily launches by a rocket akin to SpaceX's Starship.

"There's no point in trying to see if it's technically achievable when the very reason you're creating the thing in the first place [net zero] is going to be null and void," says Andrew Wilson at the University of Strathclyde in the UK. He has calculated that life-cycle emissions from rocket launches and the concrete and steel involved in the antenna means space solar would have lower carbon dioxide emissions per unit of energy than coal, oil and gas, though higher than from terrestrial renewables.

Soltau notes that Wilson's study looked at 40-year-old technologies, which have seen significant developments that would cut CO_2 emissions. ▮

NASA

Solar panels in low Earth orbit would see uninterrupted sun