BLICKWINKEL/ALAMY

How brine shrimps cope with salt

Brine shrimps (*Artemia* spp.) are one of only two known animals that can survive in highly saline waters. Writing in the *Proceedings of the National Academy of Sciences*, Artigas *et al*. report a biological innovation that might help these shrimps to achieve this extraordinary feat (P. Artigas *et al*. *Proc. Natl Acad. Sci. USA* **120**, e2313999120; 2023).

Membrane-bound 'pump' enzymes regulate the levels of sodium and potassium ions in cells — exporting three sodium ions out of cells for every two potassium ions imported. In addition to the regular form of these pumps, brine shrimps produce a mutant form, the expression of which increases greatly in highly saline waters.

Using cryo-electron microscopy and molecular-dynamics simulations, Artigas *et al*. analysed the structure of the mutant pump. They concluded that a lysine amino-acid residue occupies a position that would be bound by a potassium ion in the normal pump — suggesting that the mutant transports a different ratio of ions than does the normal pump. The authors' electrophysiology measurements confirmed that the mutant pumps export two sodium ions for every one potassium ion — enabling a larger-than-normal electrochemical gradient to be maintained across the cell membrane and promoting survival in high salinity.

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Medical research

A next-wave inhalable dry powder COVID vaccine

Zhou Xing & Mangalakumari Jeyanathan

Current injectable COVID-19 vaccines are unable to induce robust immunity in the mucosal tissues lining the airways. A protein-based vaccine delivered to the lungs in the form of an inhaled dry powder shows promise as a way forward. **See p.630**

At present, COVID-19 vaccines are administered through injection into muscle. Although these shots are generally effective in providing protection against developing severe disease, they are less good at preventing infection by rapidly evolving variants of the coronavirus SARS-CoV-2. These vaccines are also less effective in high-risk populations, including older people and those with immunocompromised conditions, who require frequent booster injections. Intramuscularly injected vaccines cannot induce immunity in the mucosal tissues of the airways, which is the site of SARS-CoV-2 entry. Furthermore, current COVID-19 jabs require low-temperature 'cold-chain' conditions, from their manufacture to transportation and final storage and administration. On page 630, Ye *et al*.[1] report a vaccine formulation that is not only able to induce respiratory mucosal immunity after local lung delivery, but is also inhaled as a dry powder — avoiding the need for cold chains and the use of needles.

The challenges that current COVID-19 vaccines face have led to calls for the development of next-generation vaccine strategies[2]. Such strategies are also important in preparing for future pandemics. One strategy being developed is to have shots deliverable through the airways, so as to generate mucosal immunity that today's injectable vaccines cannot provide[3,4].