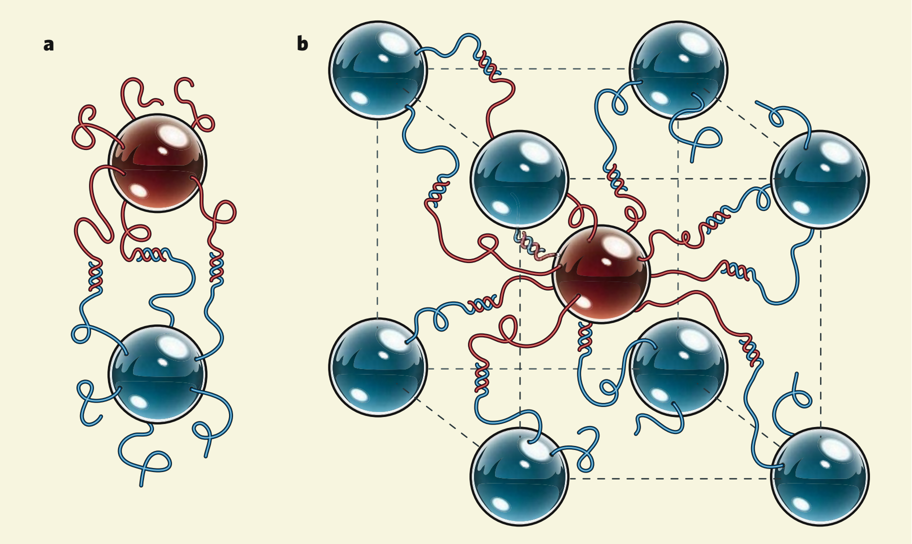

Figure 1 | Self-assembly through DNA strands. **a**, Nykypanchuk *et al.*[2] and Park *et al.*[3] mix two populations of nanoscale gold spheres, A (red) and B (blue), which have long DNA strands covalently grafted onto their surfaces. The ends of these strands contain complementary sequences. When A and B are close together, the ends hybridize into a double helix, forming bridges that pull the spheres together. **b**, Under conditions in which the bridges can form and dissociate dynamically, the spheres self-assemble into large, ordered 'CsCl' arrays with a body-centred-cubic symmetry; one unit cell is shown.

and scatters DNA strands over the gold sphere's surface, rather than at just eight nearest-neighbour locations. The exact number of strands varies from sphere to sphere.

Remarkably, ordered arrangements of the nanoparticles can form despite these random variations in their individual structure. The long spacers and the dynamic binding process seem to be crucial. Flexible spacers fluctuating in space ensure that an extended spherical cloud of strands surrounds each core, washing out the random pattern in which the strands are anchored to the particles. When the clouds of complementary neighbouring particles overlap, hybridization forms transient DNA bridges that briefly pull pairs of spheres towards each other.

In essence, the nanoparticles reach out to each other using their long spacer arms, and temporarily 'shake hands' with their complementary DNA strands. The net attractive interaction is proportional to the time-averaged number of bridges between a pair of spheres. This in turn is determined by the degree of overlap between the two DNA clouds[6].

Unlike the strictly determined binding that drives other DNA-based assembly techniques, suspensions of nanoparticles with such handshaking interactions mimic[7] the phase behaviour of atomic materials, but using engineered interactions. The ordered arrangement of A and B spheres, for example, mirrors the alternating positive and negative ions in a salt crystal, which also have a long-range, spherically symmetrical attraction.

The analogy is not perfect: Park *et al.*[3] report that one of their samples forms a face-centred-cubic, rather than a body-centred-cubic CsCl structure, when incubated at higher temperatures. They argue that this behaviour stems from a competition between the contributions to the system's total free energy of sphere entropy (which favours the more densely packed face-centred-cubic structure) and A–B binding energy (maximized by the CsCl structure).

Realizing the potential of these new materials will certainly require more research to stabilize their structure. The long DNA spacers imply that the resulting nanoparticle array is roughly 90% water, and is probably quite fragile. Still, existing techniques can probably be adapted to fill the gaps with gels or solid ceramic to yield a robust, solid material. Better models of the handshaking interaction will also need to be developed, validated and applied to computing what periodic structure a given DNA sequence will produce.

Even more exciting would be the possibility of attaching DNA to non-spherical nanoparticles — perhaps preferentially to different crystal facets — to create directional bonding and more complex structures. The ultimate dream is the creation of a DNA tool-kit that will make possible the self-assembly of nearly any material reliably at the nanoscale. ■

John C. Crocker is in the Department of Chemical and Biomolecular Engineering, University of Pennsylvania, 220 South 33rd Street, Philadelphia, Pennsylvania 19104, USA.
e-mail: jcrocker@seas.upenn.edu

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50 & 100 YEARS AGO

50 YEARS AGO

The seriousness of such neglect [of the problem of "cultural erosion"] is unmistakable to any thoughtful reader of Mr. Hoggart's book ["The Uses of Literacy"]... Writing with deep feeling and imaginative insight, Mr. Hoggart seeks to show that the under-educated in Britain — the three-quarters of the population whose schooling now ends at fifteen and whose distinguishing characteristic is rather lack of education than of money — are changing their traditional ways, and not for the better. Their freedom from poverty has exposed them to new and very deleterious influences, and while the gross prejudices and appetites are deliberately and even scientifically stimulated, the needs of the more serious-minded among them are neglected.

From *Nature* 1 February 1958.

100 YEARS AGO

The Prolongation of Life. By Elie Metchnikoff — Most people desire to live long, and hence Prof. Metchnikoff's book is sure to have many readers. He not only discusses the means by which life may be prolonged, but he also examines the question whether it is desirable to prolong it... Prof. Metchnikoff is of opinion that when old age approaches, the phagocytes, which have hitherto been man's friends, become his enemies, and hasten death by devouring the essential cells of the vital organs of the body, especially those of the nervous system. These cells are rendered particularly vulnerable to phagocytes by the action of poisons manufactured by the bacteria of the large intestine, and Prof. Metchnikoff suggests that this might to a large extent be prevented by taking skimmed milk which has been boiled and rapidly cooled, and on which pure cultures of the Bulgarian bacillus have been sown. This produces a pleasant, sour, curdled milk containing about 10 grams of lactic acid per litre, the lactic acid of which prevents intestinal putrefaction.

From *Nature* 30 January 1908.