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LIQUID CRYSTALS FROM DNA

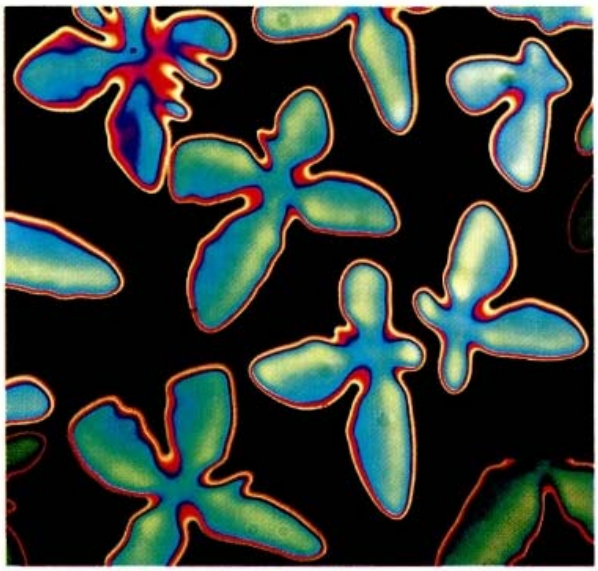
SELF-ASSEMBLY: Stacking of short DNA duplexes suggests origins of nucleic acid formation

FROM A STRUCTURAL point of view, the molecules that make up liquid crystals tend to resemble supermodels: They're long and lean. A team of researchers in Italy and Colorado has now demonstrated that small pieces of double-stranded DNA, 6 to 20 base pairs long, can assemble into liquid crystals despite their stubby stature (*Science* **2007**, *318*, 1276). The work suggests how nucleic acids might have been formed prebiotically.

Scientists have known since the 1940s that long strands of duplex DNA will align to form liquid crystals, but shorter strands were overlooked because of their squat shape. A team of physicists led by Tommaso G. Bellini of the University of Milan and Noel A. Clark of the University of Colorado, Boulder, were surprised to find that short DNA fragments will stack upon one another like cola cans, forming the long, slender structures needed to make a liquid crystal.

The small DNA chunks don't form covalent links. Rather, they stack together through mild, reversible physical links, Bellini explains. Single strands of DNA won't interact in this way, so the researchers mixed short fragments of single-stranded and double-stranded DNA to see if the mix would disrupt liquid-crystal formation.

"Here we got another surprise," Bellini says. The double-stranded DNA phase separates from the single-stranded DNA, forming liquid-crystal droplets. The finding suggests a possible mechanism for the formation of DNA and RNA from a prebiotic soup of chemicals, according to Bellini and Clark.



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Liquid crystals made of short DNA duplexes.

"Our vision is that from the collection of ancient molecules, short RNAs or some structurally related precursor emerged as those molecular fragments most capable of condensing into liquid-crystal droplets and hence selectively developing into long molecules," Clark says.

"This is a very interesting result," comments Randall D. Kamien, a physics professor and liquid-crystal expert at the University of Pennsylvania. "In the past, liquid-crystalline order in biomolecules was considered a side effect of their rigidity and the packing constraints in the cell. Now, we have a strong hint that the liquid-crystalline order played a role in generating these long, stiff chains. Apparently, liquid-crystalline order is not just inevitable in a biophysical context, but it is essential for life, creating a crucible for autocatalytic reactions," he says.—BETHANY HALFORD