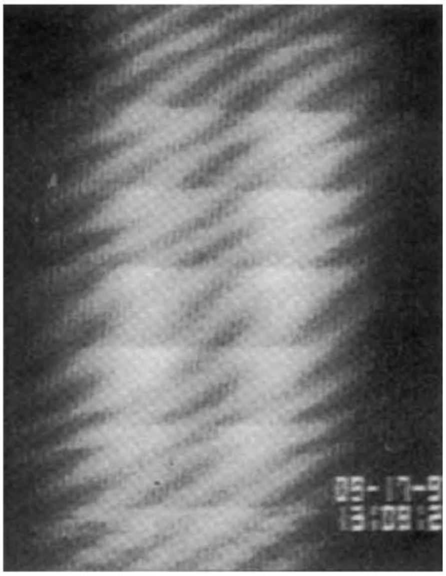

FIG. 2 A stripe pattern observed on a Langmuir monolayer of a fatty acid by polarized fluorescence microscopy. The slow variation in shade across each stripe is due to a continuous change in the molecular azimuthal tilt direction. Such continuous variation suggests that the monolayer is in a hexatic phase, as it should not occur in a true two-dimensional crystal. (Courtesy of C. M. Knobler.)

molecular lattice of tiny parts of such a pattern.

There are several mechanisms by which chirality can be introduced into a system of inherently achiral units. The achiral unit can separate into two chiral constituents. This may be what is seen by Eckhardt and colleagues: the two molecular enantiomers normally combine to make an achiral dimer, but can be induced to separate into distinct phases. Alternatively, an achiral molecule can choose to pack in a chiral lattice. Such a packing has been observed in a thin Langmuir–Blodgett film of an achiral fatty-acid salt[7].

Also, rod-shaped molecules packed hexagonally (a physicist's conception of a liquid crystal) can form a tilted phase in which the tilt direction is neither directly towards a nearest-neighbour nor exactly between nearest-neighbours, thus breaking the mirror symmetry. This is the structure of the liquid-crystal smectic L phase which has long-range bond-orientational order but only short-range translational order (a hexatic phase).

A recent theoretical paper by Selinger *et al.*[8] describes a phase diagram for the patterns formed by a chiral hexatic system that predicts striped patterns as well as two-dimensional modulation giving, for example, a square pattern. Their theory predicts two types of stripes, one in which the order parameter varies continuously and one with sharp domain walls. Changes in temperature can alter the stripe widths as well as induce transitions between patterns.

There is striking qualitative agreement between the predictions of Selinger *et al.* and the observations by Maclennan and Seul of patterns formed on freely suspended liquid-crystal films[5]. These authors observed the evolution from sharp stripes to a two-dimensional modulation (a honeycomb) with increasing temperature under conditions at which the surface layers of the film are in a hexatic phase. They also found intriguing and regular cusp defects in the stripe patterns and the twelve-armed star pattern already mentioned (Fig. 1), both of which will serve as a further challenge for theory.

The situation is not so clear for the patterns formed on Langmuir monolayers. The stripes observed at the air/water interface are neither a sine wave nor a square wave (sawtooth might be a better description of the pattern in Fig. 2). Perhaps more problematically, as the microscopic structure of the phase is not known with certainty, it is unclear if the phase is chiral or even if it is hexatic. An additional complication is that Eckhardt *et al.* observe their monolayer after transferring it onto a solid support. These factors make it difficult to apply Selinger's theory directly.

At the most basic level, the connection between chiral symmetry breaking and pattern formation is of interest because it is another example of the ways in which structure and symmetry at the molecular level make themselves felt macroscopically. Perhaps the most dramatic and amazing example of this is crystal faceting. There may be many technological uses for regular patterns — in displays, gratings and electronic devices, for example. If we can understand the relationship between molecular architecture and the patterns formed it will be the first step towards engineering molecules to form the types of patterns we need. The huge range of length scales (1 Å to 100 μm) that can be observed with the atomic-force microscope and other scanning probe microscopes make it possible to explore this question directly. □

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DAEDALUS

Hereditary bias

LAST week Daedalus suggested that a woman's two ovaries compete each month for the chance to ovulate. He now explains why. Each ovary, he reckons, has its own genetic strategy. It will split the 24 human chromosome pairs with a certain bias, preferentially retaining some chromosomes in the ovum while discarding others. Meanwhile the other ovary, like a rival college, is turning out graduates with a different taste and style. Each month, the ovaries compete for the honour of putting up one of their own graduates for a potential pregnancy.

And this, says Daedalus, is the point of having two ovaries. Like the left and right sides of the brain, they have different strengths. Their owner instinctively judges her social circumstances and potential mates, and unconsciously shifts her hormonal balance to release ova more often from the favoured ovary. In ordered circumstances, for example, the left ovary might be preferred; it would release ova with a logical and systematic endowment. In more chaotic times, the right ovary's graduates would promote the genetic bases of opportunism and creative flair.

Each ovum seeks to implement the genetic strategy of its home ovary. Launched into a mass of eager sperms, it will scan its suitors critically, looking for the best genetic match. It may not find it. It is the extreme choosiness of ova, says Daedalus, that makes pregnancy so uncertain.

The male response (as ever) is to play the field. 24 chromosome pairs can be divided up to generate 2^{24} different possible sperms: about 17 million, a good order-of-magnitude estimate of an ejaculatory content. And this is why the male makes so many sperms. He is covering all genetic permutations, so that even the choosiest ovum should find its ideal partner among them. Yet even here there is room for strategy. Left and right testicles may also bias their output in the light of the prevailing conditions, to maximize the competitive fitness of the resulting offspring.

This ability to bias our children's character to suit the immediate circumstances, gives us a mighty advantage over strictly mendelian creatures. Indeed, says Daedalus, this must be the secret of the speed and vigour of human evolution, and the wonderful adaptability of our species. He is now seeking evidence of sperm preferences among ova *in vitro*. An ideally choosy ovum should reject the first $(1/e)$th of the candidates, while noting their characters. Having thus sized up the field, it should accept the next sperm that is superior to any of the previous sample.

David Jones